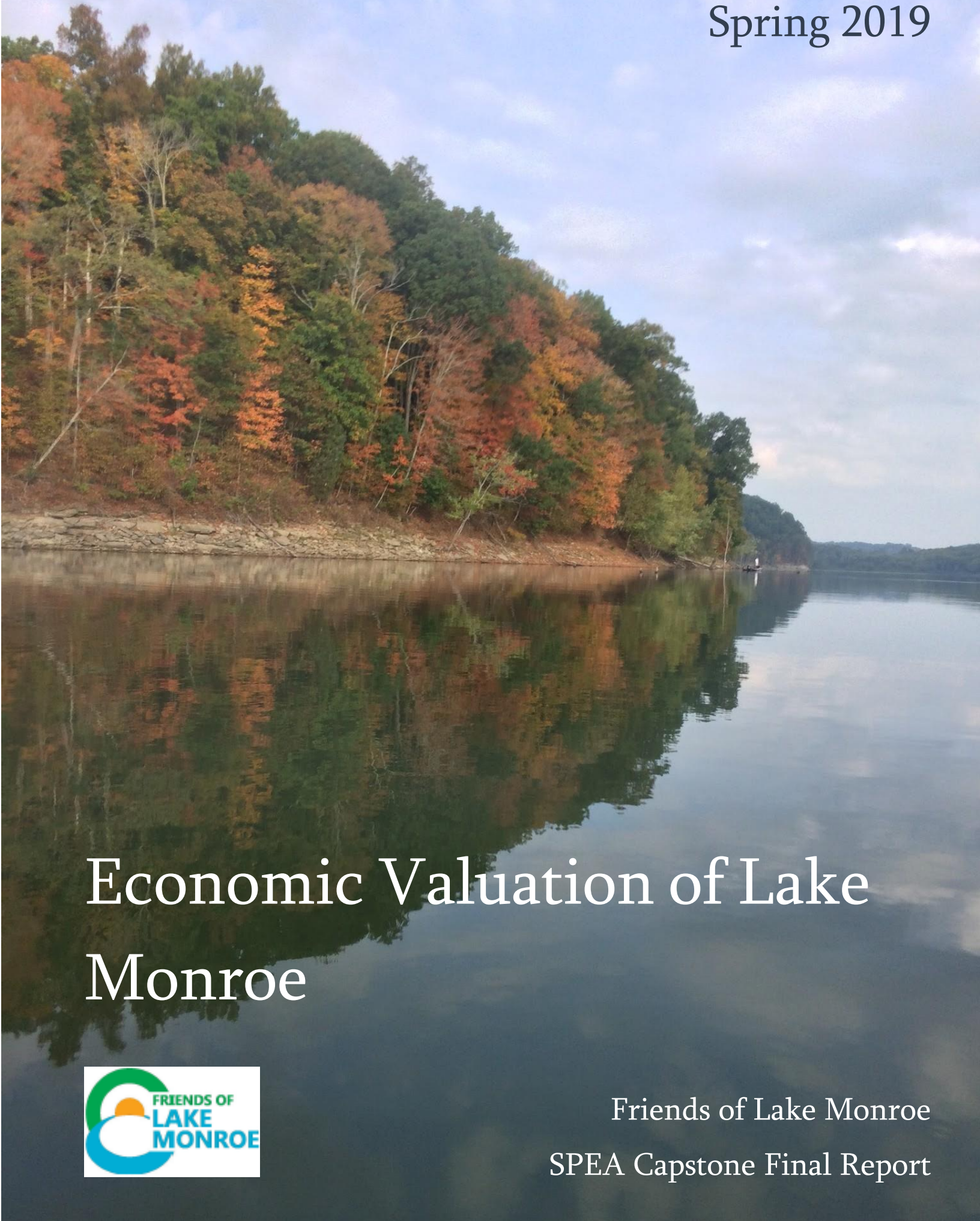
EXHIBIT 3, ATTACHMENT A:

Friends of Lake Monroe's Economic Valuation (2019)

Spring 2019



Economic Valuation of Lake Monroe

Friends of Lake Monroe

SPEA Capstone Final Report

Executive Summary

Lake Monroe was constructed in 1964 to serve as the primary drinking water source for Indiana University and Bloomington, Indiana. Its watershed extends into Monroe, Brown, Jackson, Bartholomew, and Lawrence counties and provides numerous economic and use benefits to the watershed communities. The lake draws visitors from across the state for recreation, such as boating or fishing. While Lake Monroe's water quality is a significant factor for these uses, it can also affect the values of properties near the lake. Furthermore, the community derives benefit from the wide arrange of ecosystem services the lake provides.

Friends of Lake Monroe (FoLM) wants to improve their ability to educate watershed communities about the benefits provided by Lake Monroe. FoLM is currently working on an application to the Indiana Department of Environmental Management for a Clean Water Act Section 319 grant. FoLM plans to use the grant funds to develop a Watershed Management Plan for Lake Monroe, which will be used to implement a water fund formed of contributions from communities in the watershed. To help FoLM advocate more effectively for the protection, maintenance, and enhancement of the lake among disinterested communities, FoLM requested we assess the economic value of Lake Monroe to surrounding communities. This Capstone report presents our findings.

We divided work on this project into four groups: water quality, recreation and local business stakeholders, ecosystem services, and contingent valuation study. The water quality group estimated the effect of water quality on treatment costs and property values. The stakeholder researched the economic impact of recreational activities on and around Lake Monroe and examined how businesses benefit from lake-related traffic. The ecosystem services group conducted a literature review to obtain monetary ranges of ecosystem services that may apply to Lake Monroe. Finally, the contingent valuation study group developed a survey, a guide for implementation, a budget, and steps for analyzing the results. These products will contribute to FoLM's understanding of the tangible and intangible benefits of Lake Monroe to the surrounding counties.

Water Quality

The water quality group estimated the effects of water quality on treatment costs and property values using two different approaches. First, we gathered monthly expenditures to treat three different chemicals used to treat drinking water, including sodium hydroxide, sodium hypochlorite, and alum. City of Bloomington Utilities (CBU) provided historic budget data related to these three chemicals, which allowed us to estimate monthly expenditures. Total monthly costs of the chemicals under normal conditions were $42,613. In contrast, total monthly costs under conditions with high organic content were $114,118: almost three times the costs under normal conditions.

Second, we forecasted the effects of water quality on property values within a quarter mile of the lake using water quality data from CBU and property data acquired from Brown, Jackson, and Monroe counties. Results from the water quality analysis showed a long-term (2006-2019) decrease in turbidity values and a short-term (2016-19) increase in turbidity. Based on these trends, a long-term decrease in turbidity could lead to a median property value increase of $15,943.44

over the next 50 years, while a continuation of the short-term increase in turbidity could lead to a median property value decrease of $29,358.66 over the same period. Our estimation models show that a decrease in water quality could lead to an increase in treatment costs, and a decrease in property values.

Recreation and Local Business Stakeholders

The recreation and local business stakeholders team analyzed the economic value of recreational activities and surveyed local businesses on how they benefit from Lake Monroe. First, our team curated a comprehensive stakeholder list and identified local business and recreational stakeholders. We then gathered information from the Indiana Department of Natural Resources (IDNR), Indiana Bass Fishing League (IBFL), Army Corps of Engineers (USACE), and Visit Bloomington. Second, we surveyed local businesses to learn how lake-related traffic impacts their operations and revenue streams. In 2016, the USACE reported that Lake Monroe recreation generated $21,579,290 in total sales within the 30 miles immediately surrounding the lake. Additionally, recreational activities at Lake Monroe generated $7,789,260 in labor income. Our findings show that Lake Monroe is economically valuable to a wide range of stakeholders in the watershed.

Ecosystem Services

The ecosystem services group conducted a literature review to obtain estimated monetary ranges for ecosystem services provided by Lake Monroe. We principally relied on the information and data provided by Costanza et al. (1997), Costanza et al. (2014), and de Groot et al. (2012) because these sources provide an extensive amount of available data and have wide acceptance among the scientific community. Through this literature review, we found monetary values for 13 ecosystem services: biological control, climate regulation, cultural benefits, disturbances regulation, erosion control, food production, gas regulation, genetic resources, human health, nutrient cycling, pollination, raw materials, and species refugia. These values are an approximate estimate of the ecosystem services value provided by Lake Monroe.

Contingent Valuation Study

The contingent valuation (CV) group researched and developed a CV study to provide a value for Lake Monroe's intangible benefits. After an extensive literature review, we recommended FoLM launch a mail-based CV survey to Monroe, Jackson, and Brown counties. In addition to writing the survey, we created a guide for the implementation, code and instructions for analyzing results, and estimated expenses for FoLM. Appendix K includes a detailed record of the decision process and rationale for our recommendations.

List of Acronyms

BMP – Best Management Practices

CBU – City of Bloomington Utilities

CDC – Centers for Disease Control

CV – Contingent Valuation

EPA – Environmental Protection Agency

FoLM – Friends of Lake Monroe

GBCC – Greater Bloomington Chamber of Commerce

GIS – Geographic Information Systems

IGIO – Indiana Geographic Information Office

IBFL – Indiana Bass Fishing League

IDNR – Indiana Department of Natural Resources

IU – Indiana University

MWTP – Monroe Water Treatment Plant

RECONS – Regional Economic System

SPEA – The O'Neill School of Public and Environmental Affairs

USACE – US Army Corps of Engineers

VB – Visit Bloomington

VERS – Visitation Estimation & Reporting System

WTA – Willingness-to-accept

WTP – Willingness-to-pay

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1. Overview

FoLM needed information about the value of Lake Monroe to advocate for the protection, maintenance, and enhancement of the lake, both among watershed communities and in their Section 319 grant application. FoLM contracted with Indiana University's (IU) O'Neill School of Public and Environmental Affairs (SPEA)'s Spring 2019 Capstone class to perform an economic analysis of the benefits Lake Monroe provides to surrounding communities.

As the largest reservoir in Indiana, Lake Monroe benefits residents of the state in many valuable ways. In addition to providing drinking water to the City of Bloomington, the lake is a popular recreation area where residents come to boat, fish, and swim. The visitors who come to Lake Monroe for these activities over the summer season help support local businesses, which benefit from the increased traffic. This report discusses methods used to capture these benefits and assign economic values associated with degradation of the lake's ecosystem, which FoLM may use while planning the implementation of best management practices (BMP) within Lake Monroe's watershed. While the information provided throughout this report is as comprehensive as possible, gaps in data or expertise may still be present. Therefore, FoLM should confer with members or stakeholders when using this data throughout their planning and decision-making process. The authors and contributors to this report are not responsible for the ways in which our client uses the information it contains.

This report includes three major categories of benefits. First, we examine the impact of degradation in Lake Monroe's water quality on treatment costs and property values. Second, we assess the economic value of recreation and the associated benefits local businesses receive from visitors to the lake. Finally, we provide a literature review of the economic benefits of various lake ecosystem services. The Capstone team identified these categories as key areas where FoLM can expand their knowledge of the economic value of the Lake Monroe watershed.

Due to time and information constraints, estimations in this report that do not perfectly represent Lake Monroe and the complete range of benefits that it provides. To help FoLM supplement this data, we have included a draft contingent valuation (CV) survey and with protocol for its implementation. If FoLM launches this survey, or one like it, the results could provide clearer data on how residents of Monroe, Brown, and Jackson counties value Lake Monroe's recreational, ecosystem, and aesthetic benefits.

2. Economic Valuation: Water Quality and Property Values

2.1 Introduction

Lake Monroe is a primary source of drinking water for residents in the watershed. The water treatment is conducted by the Monroe Water Treatment Plant (MWTP), which is operated by the City of Bloomington Utilities (CBU) Its service covers all of Monroe County and parts of Brown County, with a total service population of 120,000 people. On average, the MWTP treats 13 million gallons of water per day. The contaminants in lake water include: (1) organic chemical compounds, such as agricultural and industrial byproducts; (2) inorganic contaminants, such as metals and salts; (3) biological pollutants, such as algae, bacteria, and viruses; (4) pesticides and herbicides; and (5) radioactive materials.

The MWTP's treatment process involves five steps: (1) rapidly mixing positively-charged chemicals with pumped water for coagulation and flocculation; (2) moving water slowly in settling basin for floc sedimentation; (3) driving water into the sideway inclined with a particular angle; (4) filtering water in tubes to remove dissolved particles; and (5) adding chlorine for disinfection. In recent years, eutrophication in Lake Monroe has caused algal blooms, which increases water treatment costs. When the blooms occur during the summer, the MWTP increases chlorine and filtering operations and must use an ultrasonic device to reduce the negative impacts of the bloom.

The water quality's group objective was to connect water quality to measurable monetary values. The variables we chose to analyze were the effects of water quality on water treatment costs and property values of land around the lake. The CBU provided the water quality data for this analysis. We used the water quality parameters turbidity and UV254; turbidity is a measure of the suspended particles, while UV254 is a measurement of organic content. We retrieved property value data and geographic information systems (GIS) data from the Monroe County Government. We hypothesized that as the amount of organic matter in the water increases, water treatment costs will increase. In our analysis, we also considered the effects of degraded water quality on property values, hypothesizing that as organic matter increased and water quality in the lake decreased, property values would decrease.

2.2 Methods

2.2.1 Water Quality Data Acquisition and Management

The CBU's data on lake water quality represent hourly measures of several water quality parameters at the MWTP's point of intake from October 2006 to January 2019. Following expert opinion, we used UV254 and turbidity as the most direct measures of water quality for our purposes. The UV254 parameter uses UV light to measure organic matter content in the water, including algae, and is considered one of the most influential variables in assessing water treatment needs. Because UV254 data are only available from September 2016 onward, we used turbidity as a proxy for UV254. While turbidity does not distinguish between organic matter and other suspended solids, it does have the added benefit of relating to property value, as turbidity measures clarity and therefore relates to aesthetic value of the lake (Poor et al. 2007). Both of these parameters where found to be closely related (Figure 1: $R^2 = 0.7158$, $p < 0.0001$). The agreement between UV254 and turbidity justifies our use of turbidity for most of our analysis. (Figure 2)

(City of Bloomington Utilities [raw data], 2019). We aggregated the data using monthly average values with SAS 9.4 software for further analysis and to create legible figures.

Figure 1: Monthly values and trendlines of turbidity and UV254 since 2016.

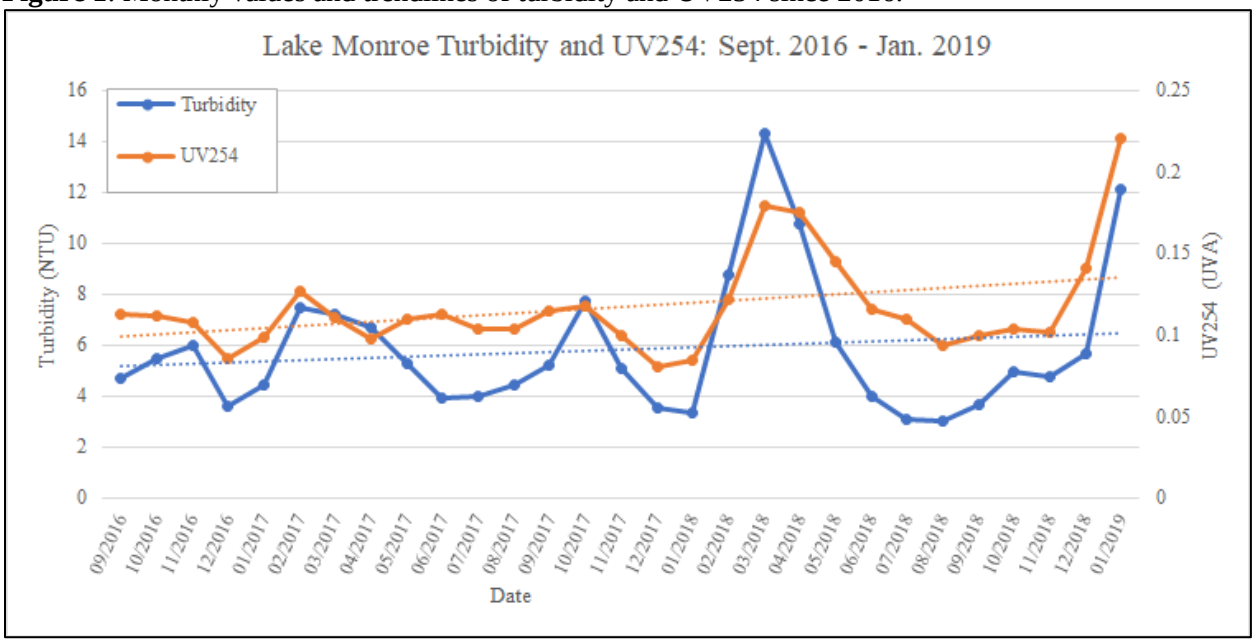
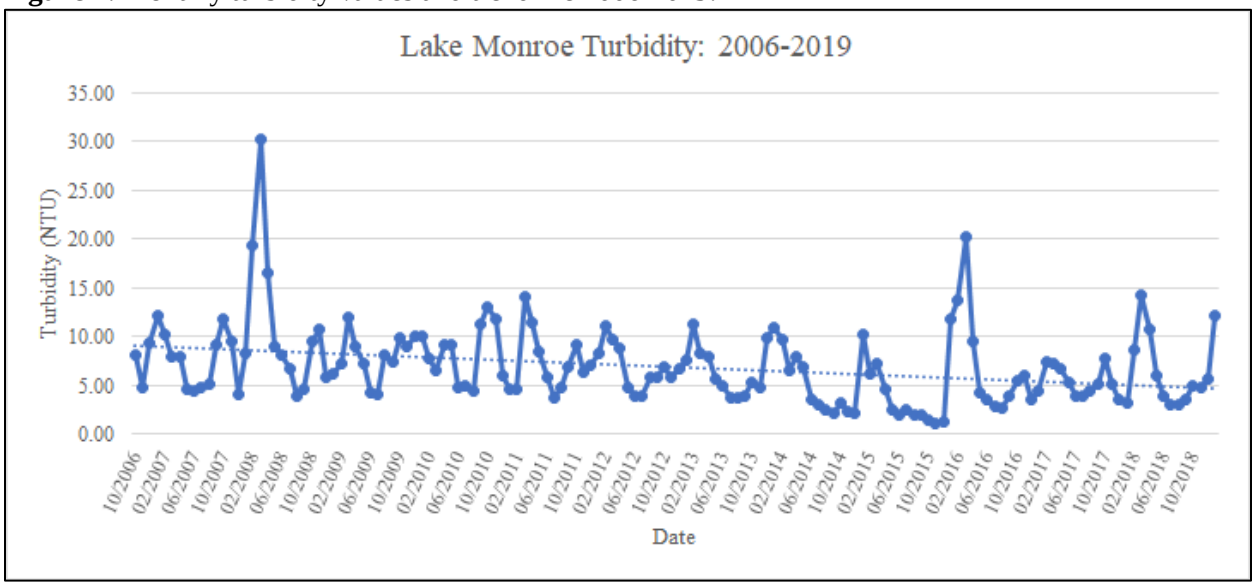


Figure 2: Monthly turbidity values and trendline 2006-2019.



2.2.2 Water Treatment Costs

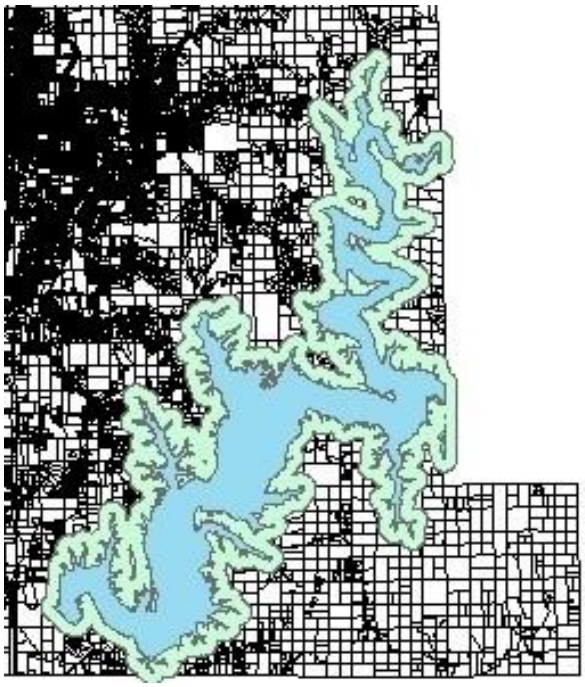
The CBU provided cost data for alum, NaOH, and NaClO at the MWTP. The only data they were able to provide consisted of aggregate monthly values from January 2018 to February 2019. Robust analysis of this data was not possible due to small sample size. Instead, we derived our estimates of water treatment costs from the expert opinion of current plant management.

2.2.3 Property Value Data and Management

document a statistically significant relationship between water quality and property values (Nicholls and Crompton, 2018). Nicholls and Crompton collected and reviewed 48 publications; we applied two studies from their work to our research of Lake Monroe because of their focus on turbidity.

Kurt Babcock at the Monroe County Government supplied 1994-2019 property data for Monroe County. By using the GIS software, ArcMap 10.7, we created a 0.25-mile buffer around a "Lakes" layer and intersected it with the "Parcel Property" layer. Using that intersection, we determined all properties that would be impacted by changes in water quality, particularly turbidity, and thus created our study area (Figure 3) (Monroe County Stormwater [raw data], 2019). We used total assessed value in our analysis, where assessments were from January 1st each year. Because it is difficult to assess how the seasonal fluctuations in water quality influence property value, we were unable to find any significant relationships using this simple model.

Figure 3: Quarter-mile buffer placed around Lake Monroe used to intersect Monroe County parcel layer.



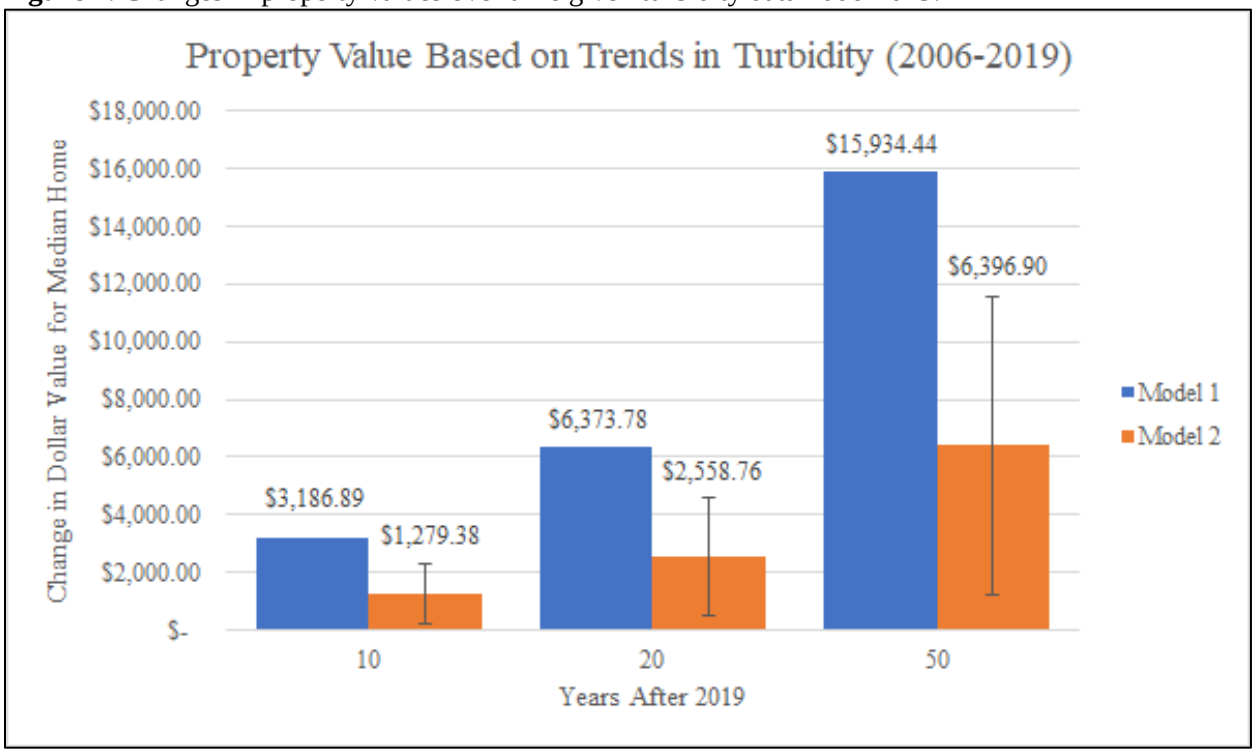
Hedonic studies are commonly used to assess the impact of multiple factors on property value, allowing the user to determine how much each factor contributes to the overall value. Because water quality data represented only one sampling point in the lake and there was no other data with which to compare it, a complete hedonic study of Lake Monroe was not possible to conduct within the timeframe of this project. Instead, we conducted a literature review to derive information on the impact of water quality on property value from other hedonic studies of waterbodies comparable to Lake Monroe across the Midwest. Our estimates of water quality impact are based on these studies. We chose to utilize the marginal effective rates (MER) associated with other lakes

as there is precedent in doing so for in the regulatory impact analysis of the Clean Water Rule (Walsh et al., 2011).

We estimated the impact turbidity has on lake-adjacent properties for areas like Lake Monroe based on two studies and their marginal effective rates (Nicholls and Crompton, 2018). For Model 1, the marginal effective rate was 1.07% per Nephelometric Turbidity Unit (NTU), the unit of measurement for turbidity. For Model 2, we applied a MER from a previous study that found "a one standard deviation (SD) change in turbidity from the mean (±4.9 TU) caused prices to vary from about - $82 to - $771 (1977 dollars)" (Nicholls and Crompton, 2018). We then adjusted these values for inflation using an inflation calculator and then converted the values from dollars per standard deviation to dollars per NTU. For our forecast in Model 2, we use the mean but demonstrate the possible range.

Using the information on water quality from 2006 to 2019 (Figure 2), we projected the change in lake turbidity at 10, 20, and 50 years using a simple linear regression model with a negative rate of -0.3504 NTU/year ($R^2 = 0.1001$, $p < 0.0001$) (Figure 4).

Figure 4: Changes in property values over time given turbidity data 2006-2019.



Looking at the last three years in isolation (Figure 5), turbidity in Lake Monroe is increasing on average, though not significantly with a rate of 0.6456 NTU/year ($R^2 = 0.038$, $p = 0.270$). We utilized this trendline to again project the change in lake turbidity at 10, 20, and 50 years (Figure 6).

Figure 5: Monthly values of turbidity and trendline from 2016 to present.

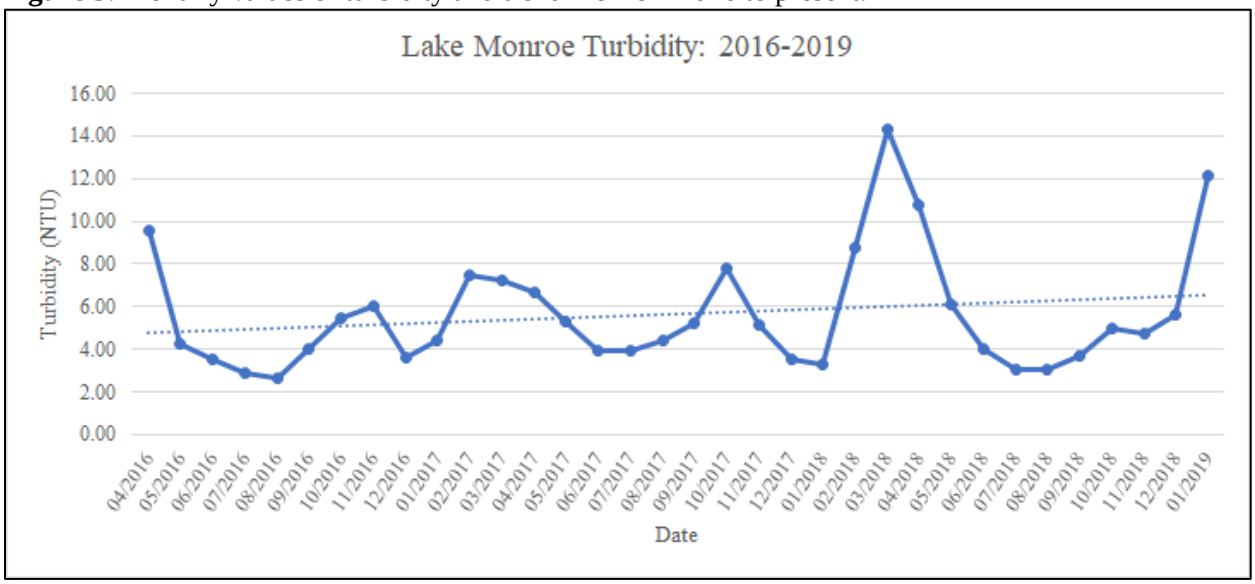
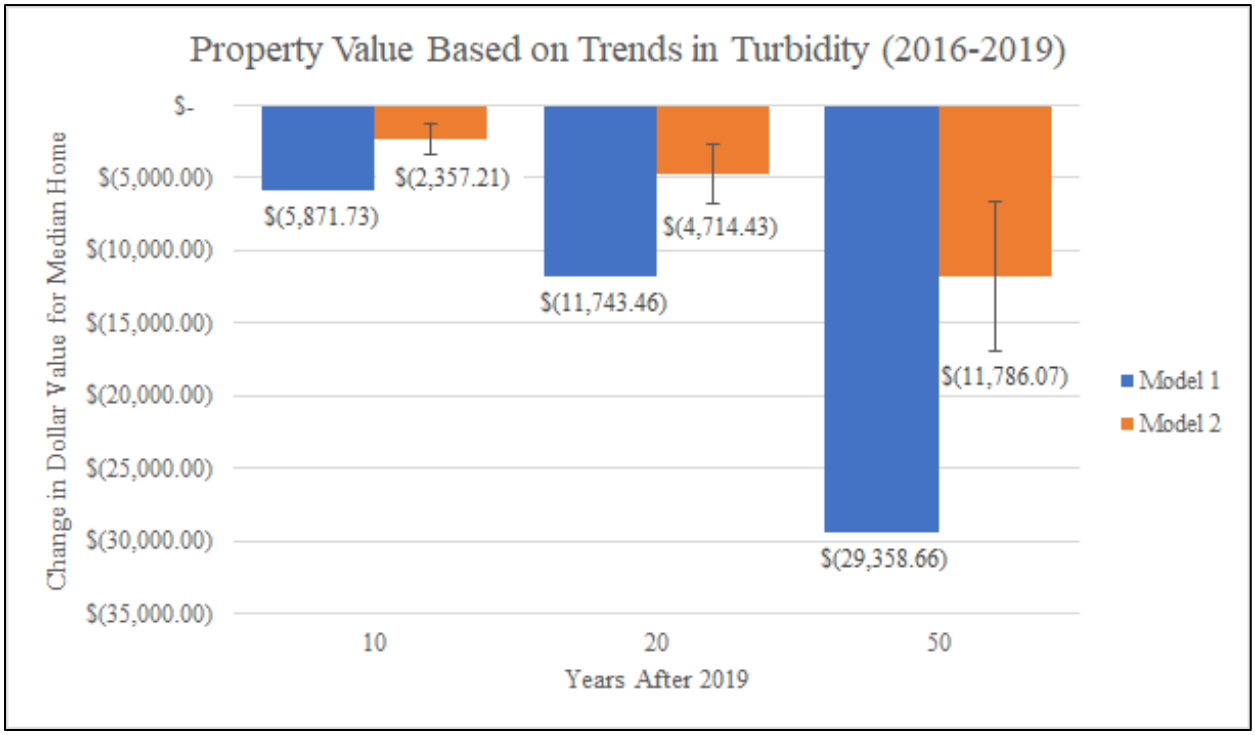


Figure 6: Changes in property values over time given turbidity data 2016 to present.



To assess a range of possible future states of turbidity in Lake Monroe, we calculated impacts to property value based on both the long-term downward trend and more recent upward trend in turbidity. Projected property value is then a product of how we expect the lake to change, based on these regressions, and how we expect property values to respond based on the literature. We present results as the expected change in property value due to turbidity increase/decrease to the median home.

2.3 Results

2.3.1 Water Quality vs. Water Treatment Costs

Analysis of the water quality data supplied by the CBU shows a slight increase in turbidity and UV254 values over the last three years (Figure 1). The highest values for these parameters occurred typically in early spring or late winter which might be associated snowmelt inputs. The other noticeable trend is that the maximum values in these spring months is becoming larger. The peak values in 2018 are much higher than the values in previous years.

Due to limitations with treatment cost data we did not have a good dataset to compare our water quality information to. The only data available were expenditures on three chemicals used in the treatment process over the last year. We were however able to uncover costs of chemicals and the purchasing habits of the wastewater treatment plant during periods of higher organic activity. During periods, the treatment plant requires more trucks of alum, sodium hydroxide, and sodium hypochlorite (Table 1) (City of Bloomington Utilities [raw data], n.d.). We estimated average monthly chemical cost values and use these to estimate costs of various high organic events. The results of those estimates are only a reflection of increased chemical costs. Other factors potentially affected by degrading water quality are labor, infrastructure repair/modification, and general maintenance. As an example of the effectiveness of our model we ran analysis on 2018 chemical costs. The actual cost of chemicals based on data supplied by CBU was $644,277 (US Army Corps of Engineers, 2017). The value we calculated using our estimation model was $654,366.

Table 1: Breakdown of treatments for each chemical and associated monthly costs. An estimated total monthly chemical cost is $42,613 for a normal year and $114,118 for a high organic content year.

Chemicals	Cost per Treatment	Treatments per Week (Normal Conditions)	Treatments Per Week (High Organic Conditions)	Treatments Per Month (Normal Conditions)	Treatments Per Month (High Organic Conditions)	Monthly Cost (Normal Conditions)	Monthly Cost (High Organic Conditions)
Sodium Hydroxide	$7,100	1 every 2-3 weeks	1 every week	1.73	4.33	$12,283	$30,743
Sodium Hypo-chlorite	$4,000	1 every 2 weeks	2 every week	2.17	8.66	$8,680	$34,640
Alum	$5,000	1 every week	2-3 (2.5) every week	4.33	10.83	$21,650	$48,735
Total Normal Monthly Cost:		$42,613					
Total High Organic Monthly Cost:		$114,118					
2018 Chemical Cost:		$644,277					
Cost using our estimation (2-month Event)		$654,366					

2.3.2 Estimated Annual Costs Associated with Increasing Organic Matter

Normal year - no high organic content months:

TC = $42,613*(12 months) = **$511,356**

Short term high organic content event - June-August (3-month high organic event)

TC=$42,613*(9 months) + $144,118*(3 months) = **$815,871**

Long term high organic content event - April- September (6 Month Event)

TC=$42,613*(6 months) + $144,118* (6 months) = **$1,120,386**

2.3.3 Property Values

A review various studies made clear the connection between water quality and property values. Horsch and Lewis conducted a hedonic valuation study to determine the impact of Eurasian milfoil, an invasive aquatic species, on local property values (2009). The study determined that the surrounding properties saw an average decrease in property value of about 13%. The authors suggested that a lake will likely have large quantities of Eurasian milfoil if it that has high recreational use predominately in the form of boating (Horsch and Lewis, 2009). This relates to Lake Monroe because as Eurasian milfoil has been identified in the lake, which is also has heavy boating activity.

Poor, Pessagno, and Paul (2007) took an approach that could be useful for FoML; the authors modeled hedonic pricing for an entire sub-watershed. This was one of the first studies to look at hedonic pricing at the watershed level. Utilizing sampling stations throughout the watershed, they measured total suspended solids and dissolved inorganic nitrogen, finding marginal implicit prices of (-$1086) and (-$17,642), respectively. The watershed was adjacent to the Chesapeake Bay, and the authors found that residents had a higher willingness-to-pay and were more knowledgeable about water quality issues (Poor et al., 2007). We recommend FoLM contract a firm to conduct a study in the style of Poor et al. (2007), because it could demonstrate the wide range of water quality parameters that affect lake value.

Utilizing the MER from studies conducted on other lakes, we were able to develop a general idea of the impact that the turbidity trends and at a larger scale, water quality trends, of Lake Monroe have on the surrounding properties. Using the trendlines of the turbidity data with these marginal effective rates, we were able to forecast the net cost or net gain of property values over 10, 20 and 50 years. Following the trendline over the last 13 years, we noted a decrease in turbidity of (–0.3504) NTU per year. With this trend, we saw a gain of $15,934.44 for Model 1 and a range of $1,229.90 to $11,563.73 for Model 2 over 50 years (Figure 4). In our analysis of the trend of the last 3 years' turbidity values of 0.6456 NTU per year, we see a loss of $29,358.66 for Model 1 and a range of $2,266.06 to $21,305.77 over 50 years (Figure 6). The 3-year trend of turbidity should be used with caution as not enough time has passed to determine if this is a significant trend (R^2 = 0.038, p = 0.270).

FoLM also asked us to utilize these models to forecast the aggregate changes in property values for the entire buffer area by multiplying model values by the total number of homes in the buffer. Please note that this method creates more room for error by making broad assumptions about the

median property value. It does not accurately represent the actual forecast that a true hedonic model would assess (Table 2).

Table 2: The effect on median property price multiplied by the total number of properties analyzed around Lake Monroe.

Aggregate Change in Property Values for the 0.25-mile Buffer Surrounding Lake Monroe						
	Long-term trend (2006 - 2019)			Short-term trend (2016 - 2019)		
Projection into the future (years)	10	20	50	10	20	50
Model 1	$7,820,623	$5,641,246	$39,103,115	-$14,409,230	-$28,818,460	-$72,046,151
Model 2	$3,139,599	$6,279,199	$15,697,998	-$5,784,604	-$11,569,209	-$28,923,024

2.4 Conclusions

2.4.1 Treatment Cost vs. Water Quality

The water quality group provided an estimate for the effect that water quality has on water treatment costs. Our original intent was to compare our water quality data to multiple years-worth of costs and estimate the economic value of water quality in terms of treatment costs. Although our dataset was limited, we believe this could be a possibility for a future study if someone were able to access treatment cost data for a longer time period. With that said, we were able to take information and provide an estimated monthly cost of water quality to the MWTP. The model we created in Table 1 closely matched the actual water treatment costs for 2018, suggesting that the model is fairly accurate. The difference in costs between months with high organic content and normal conditions accounts to $71,505. There is a strong impact on the chemical costs of the MWTP and the organic content of the water in Lake Monroe. We captured the largest water quality cost for the MWTP.

Future research may to capture some of the costs our group was able to complete during this Capstone. Some of the maintenance costs, such as cleaning and eventual replacement of filters, are not captured by our model and estimations. We suspect that higher organic matter would place a greater burden on plant facilities and result in higher maintenance costs. Because of the data missing from our model, the values we estimate are a lower bound for the effect of water quality on treatment costs. A future study could improve the accuracy of the estimate by spending more time collecting data on all factors and costs that go into this process.

2.4.2 Property Values vs. Water Quality

We forecasted the affect that degrading water quality could have on property values that border the lake. Using MARs calculated in other studies around the United States, we were able to use the turbidity data to establish trends. However, these trends were of low significance and we recommend they not be used in a decision-making process, but as a starting point in understanding hedonic pricing relationships. Even so, the existing research on the topic points to a relationship between property values and water quality, suggesting that degrading water quality diminishes values of surrounding properties. Therefore, we recommend that FoLM coordinate a complete hedonic pricing study.

Near the end of our study, USACE provided us with a comprehensive dataset of water quality values taken monthly since 1971 from over 40 locations on Lake Monroe. This dataset may be

useful in completing a more robust study and will likely show stronger trends than only utilizing data from the last 13 years. Time and data availability limited the scope of our analysis and are the reason that we did not analyze this dataset.

3. Economic Valuation: Recreation and Local Business Stakeholders

3.1 Introduction

To determine the economic value of recreational activities on and around Lake Monroe and to examine how local businesses benefit from lake-related traffic, the stakeholders group began by consulting with organizations within the watershed. Our group wanted to ensure all stakeholders were adequately informed of this Capstone project and given a chance to volunteer data to help with the appraisal of the economic value of Lake Monroe. We identified stakeholders based on either their affiliation with lake-related recreational activities or their proximity to Lake Monroe. We also collected quantitative information regarding revenue generated from recreational activities. Our group launched a survey of local business stakeholders to learn if and how lake-related traffic impacts business operations and revenue streams. The following section outlines methods for stakeholder identification, data procurement, and survey development; presents findings from our research; discusses limitations; and offers recommendations moving forward.

3.2 Methods

3.2.1 Stakeholder Identification

We collaborated with FoLM to create a list of Lake Monroe recreation and local business stakeholders. We met with Visit Bloomington (VB) and the Greater Bloomington Chamber of Commerce (GBCC) who helped send the newly-created survey to local businesses.

3.2.2 Data Procurement

We acquired quantitative data from a number of State, Federal, and local sources. We retrieved current data on recreational licenses from the Indiana Department of Natural Resources' (IDNR) website. Mr. Rex Waters, a wildlife specialist at Monroe Reservoir, referred us to the IDNR head office in Indianapolis to access IDNR revenue data from Lake Monroe for hunting, fishing, trapping, boating licenses, and permits. The USACE publishes the Fast Facts Recreation Lake Report on their website (US Army Corps of Engineers, 2017b) , which provides an estimate of the economic value of Lake Monroe. The president and vice president of the Indiana Bass Fishing League (IBFL) provided attendance records from their tournaments held at Lake Monroe dating back to 2012, as well as responses from an economic impact survey conducted by IBFL internally in 2017. Further records may be obtained by request. We downloaded a number of GIS layers: (1) the Public Land Survey System county layer; (2) the Lakes, Ponds, Reservoir, Swamps, and Marshes layer; (3) the Land Parcels shapefile; and (4) the Real Property Assessment Data spreadsheets from IndianaMap.

We spoke with USACE economist Dr. Wen Chang, in Arlington, Virginia for more information on how to process the data. Dr. Chang was willing to answer questions and could be a good point of contact for FoLM's newly-created economic impact modeling system.

3.2.3 Interviews

Visit Bloomington (VB) and the Greater Bloomington Chamber of Commerce (GBCC) are both private organizations that promote local businesses, including some which benefit from Lake Monroe. Though the USACE and the State of Indiana manage the lake, degradation of water

quality in Lake Monroe will affect business and protecting it is in the interest of these two organizations. Our group interviewed representatives of these two groups to procure information: Mr. Mike McAfee, the Executive Director at VB, and Ms. Anne Bono, Director of Advocacy & Public Policy at GBCC. In addition to personal interviews, we created and sent a survey to local businesses, explained in the following section.

3.2.4 Survey Development

Our group created a survey to gather qualitative information about how Lake Monroe affects local businesses. Our questions addressed general business practices and perspectives in a way that related businesses to the lake and generated a profile for each respondent's business. We contacted the IU's Institutional Review Board (IRB) to check if the survey required approval; our survey did not require IRB approval because the questions did not request personal information from individual citizens, only the views of businesses. We first sent the survey out to one business, Smithville Food Mart, which we selected at random from the list of local businesses gathered using GIS mapping. After speaking with representatives of VB and the GBCC, these organizations distributed our survey as a link to their respective networks through email. We discuss survey results in detail in the following section. Appendix A shows a map of survey respondents. Appendix C shows survey responses.

3.3 Results

3.3.1 Quantitative

3.3.1.1 Visit Bloomington

Visit Bloomington provided previously-conducted studies from third-party consultants on the economic impacts of tourism in Monroe County. These reports gave insight into total visitor spending for FY 2015-2017 by category and money that stays local (Table 3). For instance, VB estimates that 5% of the $400 million spent by visitors in Monroe County in 2017, $20 million, was used for recreation and entertainment. They also estimated wages, state and local taxes, and jobs generated by tourism (Table 4). In 2017, tourism generated $156 million in wages, $43 million in state and local taxes, and supported 6,648 jobs in Monroe County.

Table 3: Breakdown of visitor spending in Monroe County for 2015-2017 (Visit Bloomington, 2018).

Visitor Spending in Monroe Co.	% Spending	2015	2016	2017
Food and Beverage	34%	$123.08 Mil	$130.56 Mil	$136 Mil
Retail	21%	$76.02 Mil	$80.64 Mil	$84 Mil
Transportation	20%	$72.8 Mil	$76.8 Mil	$80 Mil
Lodging	20%	72.4 Mil	$76.8 Mil	$80 Mil
Recreation and Entertainment	5%	$18.1 Mil	$19.2 Mil	$20 Mil
Total	100%	$362 Mil	$384 Mil	$400 Mil
Money spent that stays local	63%	$228.06 Mil	$241.92 Mil	$252 Mil

Table 4: Wages, state and local taxes, and jobs generated by tourism in Monroe County for 2015-2017 (Visit Bloomington, 2018).

	2015	2016	2017
Wages generated by tourism	$144 Mil	$150 Mil	$156 Mil
State and local tax receipts generated	$39 Mil	$41 Mil	$43 Mil
Jobs supported by tourism	6,350	6,520	6,648

Mike McAffee, Executive Director of VB, estimated that 7-13% of the 2.4 million annual visitors to Monroe County, or 168,000-312,000 visitors, visit at least one of three lakes while they are in the county. The organization also profiled visitors traveling to Monroe County and categorized them by their primary purpose of visiting, the majority of which were Leisure Visitors constituting 67%, followed by Sports Visitors (17%) and Business Visitors (14%), as seen in Table 5. Leisure visitors travel to Monroe County an average of two times a year, stay overnight an average of 2.6 nights, and spend $161 per person per night while in Monroe County. Also, according to this study, leisure visitors participated in an average of 4.3 activities/attractions per trip, with 30% participating in scenic drives, 29% sightseeing, 23% visiting a park, 20% participating in outdoor activities, 12% hiking, 7% swimming, 6% camping, 4% fishing, and 4% birdwatching, among other activities.

Appendix B shows the complete results from this portion of the study, as well as documents how other categories of visitors responded to the same activities/attractions. Leisure visitors participated in more activities per trip than other groups, with sports visitors averaging 3.9 activities per trip and business visitors averaging 3.3 activities per trip. Survey respondents were also asked to strongly disagree ("1") or strongly agree ("5") with various statements regarding Bloomington. For instance, one question read: "Bloomington has great natural beauty/scenic landscapes" receiving a score of 4.1, "Bloomington is a great place for outdoor recreation" receiving a score of 4.0, "Bloomington has lots to see and do" receiving a score of 3.9, and "Bloomington is a unique destination" receiving a score of 3.7, among others.

Table 5: Visit Bloomington 2018 Visitor Profile Study, summary of results (Visit Bloomington, 2018).

Visit Bloomington 2018 Visitor Profile Study – Summary of Results			
	52Visitor Type		
	Leisure	Sports	Business
% Primary Travel Purpose	67	17	14
Average visits/year	2	3	3
Avg. Length of stay (day trip & overnight)	1.5	1.1	1.4
Avg. Length of stay (overnight)	2.6	2.2	3.3
% Overnight Visitors	63	52	58
% Day Trip Visitors	37	48	42
Avg. Travel party size (# people)	2.2	2.3	2.1

Per person, per night visit spending (USD)	$161.00	$158.00	$214.00
% Visiting in Spring	24	14	30
% Visiting in Summer	37	12	24
% Visiting in Fall	20	34	16
% Visiting in Winter	19	40	30

According to another VB study (Visit Bloomington, 2017), the county had a 4.2% increase in Annual Growth for Tourism Spending compared to a 3.2% median increase for all Indiana counties. Additionally, tourism in Monroe County is the fifth-largest industry after government, health and social services, manufacturing, and retail trade. Benefits of tourism are also described in this report, including promoting a healthy job market (7.6% of all jobs in Monroe Co. are supported by tourism to the region), contributing to the health of the public education system (revenue collected from tourism is sufficient to support 4,429 Indiana public school students), providing tax revenue ($2.6 million generated in 2017 from hotel occupancy levies, $610,000 in Indiana corporate taxes, $2.8 million in Indiana personal income tax, and $11.8 million in local property taxes), and relieving the tax burden of households. If tourism did not exist in Monroe County, each of the 61,550 households in the county would have to pay $697 more per year in taxes and capturing and retaining expenditures made by visitors (63% of money spent by visitors is returned to the local area).

3.3.1.2 Army Corps of Engineers

The USACE created their Value to the Nation initiative to determine the value that each of the civil works programs managed by USACE contribute for National Economic Development. They calculate these values annually in five major categories: flood risk management, hydropower, navigation, recreation, and water supply. The USACE begun publishing the values for each of its program through their Fast Facts online portal; and the latest data available for Monroe County are from 2016 (US Army Corps of Engineers, 2016).

USACE published Fiscal Year 2016 Fast Facts for Lake Monroe's recreational and water supply services (US Army Corps of Engineers, 2017b). Due to a lack of literature on the cost of alternative water supply methods, the USACE calculated water supply value simply on the value of the water stored. For FY2016, the water supply services of Lake Monroe provided and estimated $150 million worth of economic value. The following values for the recreation services provided by Lake Monroe were estimated for total sales, jobs provided, labor income, and value added (wages & salaries, payroll benefits, profits, rents, and indirect business taxes) within 30 miles of Lake Monroe based on annual visitation data collected by USACE, accounting for multiplier effects:

- 696,735 visitors (person-trips) in total
- $21,579,290 in total sales
- 301 Jobs
- $7,789,260 in labor income
- $11,451,458 in value added (wages & salaries, payroll benefits, profits, rents, and indirect business taxes)

Visitation data for the USACE are from the Visitation Estimation & Reporting System (VERS). The VERS program is a tool for estimating recreation visits, visitor hours, and activities at USACE recreation areas; the data is driven by Operations & Maintenance Business Information Link. They estimated spending profiles from a national visitor spending survey conducted from 2012 to 2013 and indexed using 2016 CPI figures. They computed and multiplied spending averages by visitation statistics to estimate total annual visitor spending. The Regional Economic System (RECONS) system calculated economic contributions with 2015 multipliers from "IMPLAN" models released in 2017. IMPLAN is a modeling software which utilizes some fixed marginal effect, or assumptions, to calculate recreational values. USACE visitation data are for FY 2016.

According to the Regional Economic System User Guide, "since spending in the RECONS recreation module is measured on a party day/night basis, RECONS converts person visits or trips to party visits" by dividing by an average party size for each segment (USACE IWR, 2013). The USACE's campground reservation database maintains records on average camping party size. For all other visitors, the average party size for each project was estimated as a weighted average of persons per vehicle for each vehicle counter location and season, which is currently 2.08 people per trip for each project as estimated with data from VERS. The USACE uses eight segments to capture differences in spending, focusing on the following key four:

- Local visitors: visitors living within 30 miles of the project
- Non-local visitors on day trips: visitors from more than 30 miles away, no overnight stay
- Campers: visitors staying in USACE campgrounds
- Other overnight visitors: visitors staying overnight in motels, campgrounds or private homes within 30 miles of the project

The values estimated for Lake Monroe in 2016 were the first USACE calculated with the current methods of visitation data collection and are not accurately comparable to any previous years. New values to are available each year and published publicly.

3.3.1.3 Indiana Department of Natural Resources (IDNR)

IDNR has information on resident hunting, fishing, and trapping licenses readily available online. Additionally, records of non-resident licenses are available, although not by county. While we do not feel comfortable attributing dollar amounts from each hunting, fishing, or trapping license to Lake Monroe, the IDNR did provide a Lake Monroe breakdown with further information. Initially, we contacted IDNR for only boating license data, but they were able to provide much more.

The total data received from the IDNR (Table 6) shows the IDNR does attribute specific dollar amounts per year to Lake Monroe for hunting, fishing, and trapping licenses. The IDNR also issues all motorized and non-motorized boating permits for the lake, in addition to concessionaire payments, resale funds (marina/gas), and boat mooring/dock payments. The IDNR data are for the same time period as the hunting, fishing, and trapping data that are readily available on their website.

Table 6: Revenue sources of Lake Monroe. Source: Indiana Department of Natural Resources.

Monroe Lake	Calendar Years					
Revenue Sources	2006	2007	2008	2009	2010	2011
Concessionaire Payments	$281,331	$54,108	$279,885	$190,750	$220,465	$204,810
Motorized Lake Permits	$188,460	$199,000	$158,520	$180,780	$181,280	$158,640
Non-Motorized Lake Permits	$4,650	$5,260	$4,970	$6,305	$8,300	$7,990
Resale Fund (marina/gas)	$140,714	$164,482	$71,124	$100,059	$128,072	$54,220
Boat Moorings/Docks	$216,785	$112,270	$109,945	$128,375	$140,292	$102,150
Hunt/Fish/Trap Licenses	$218,818	$222,967	$206,981	$226,485	$206,510	$176,853
Totals	$1,050,758	$758,087	$831,425	$832,754	$884,919	$704,663

Monroe Lake	Calendar Years					
Revenue Sources	2012	2013	2014	2015	2016	2017
Concessionaire Payments	$256,229	$288,603	$301,033	$322,917	$311,759	$307,806
Motorized Lake Permits	$166,682	$176,462	$165,880	$177,837	$184,350	$182,825
Non-Motorized Lake Permits	$9,475	$10,950	$12,315	$14,265	$17,450	$20,705
Resale Fund (Marina/gas)	$83,066	$83,949	$80,360	$58,004	$70,900	$72,696
Boat Moorings/Docks	$151,045	$103,885	$138,055	$138,505	$144,940	$143,190
Hunt/Fish/Trap Licenses	$193,546	$201,493	$195,108	$195,931	$237,2018	$238,989
Totals	$860,043	$865,342	$892,751	$907,459	$966,607	$966,211

Revenue Sources	Totals
Concessionaire Payments	$3,019,696
Motorized Lake Permits	$2,120,716
Non-Motorized Lake Permits	$122,635
Resale Fund (marina/gas)	$1,107,646
Boat Moorings/Docks	$1,629,437
Hunt/Fish/Trap Licenses	$2,520,889

3.3.1.4 Indiana Bass Fishing League (IBFL)

The IBFL organizes competitive fishing tournaments at lakes across Indiana every year, and typically includes at least one tournament on Lake Monroe. These tournaments vary in length from one-day to multi-day events. The league has recorded registration and attendance at these tournaments for over a decade and provided some of these data for our research, although they will

need more time to locate and search through their extensive records to retrieve record relevant to only Lake Monroe (US Army Corps of Engineers, 2017a).

IBFL conducted internal economic evaluations for two of their tournaments (2014 and 2017). The 2014 evaluation was for a large tournament and the 2017 evaluation was for a small tournament. The information provided by IBFL did not contain an explanation of methods used to estimate the spending by attendees at the 2014 tournament, however it did explain that IBFL conducted a survey during the two-day tournament in 2017.

Our method for determining the Average Individual Daily Spending for the 2014 Tournament was to first find the Average Individual Total Spending by dividing the Estimated Direct Economic Impact ($297,600) by the number of attendees, which was 395. Average Individual Daily Spending, which was found to be $753.42, was then divided by the average days on site (three) to find that the Average Individual Daily Spending was $251.14. Further suggestions related to how these data may be better compared to data collected in the future can be found in 3.5.2 *Recommendations*.

For the 2017 tournament, IBFL provided the survey responses from 52 participants related to their spending, which was broken into seven categories, and time spent in the Lake Monroe area. We processed the data and derived the following metrics, seen in Table 7.

Table 7: Participant Spending Survey - 2017 IBFL Tournament at Lake Monroe. Source: Indiana Bass Fishing League.

	Vehicle Fuel	Boat Fuel	Food	Entertainment	Lodging	Tackle	Miscellany	**Totals**
All Respondents	$5,445	$4,905	$3,502	$835	$8,240	$4,480	$1,553	**$28,960**
Average Individual Spending	$113	$99	$69	$18	$173	$90	$33	**$595**
Average Individual Spending Per Day	$27.12	$23.68	$16.14	$4.29	$41.52	$21.50	$7.81	**$143**

Average Individual Spending was found for each category by simply dividing the total by 52. It is worth noting that respondents provided the number of additional days spent "prefishing", outside the two days of the tournament. Each respondent's total spending was divided by their total number of days spent in the Lake Monroe area (two tournament days plus their number of prefishing days) to find 52 respective Average Individual Spending Per Day. All 52 of these individual averages were averaged to find an overall Average Individual Spending Per Day ($143). All individual prefishing days were averaged (2.18) and added to the two tournament days to find the Average Stay in the Lake Monroe area for the tournament in days (4.18). This was the number used to calculate Average Individual Spending Per Day, by dividing Average Individual Spending by Average Stay for each spending category.

3.3.2 Qualitative

3.3.2.1 Business Stakeholder Survey Results

Our survey for business stakeholder input was available online 19 March 2019 to 5 April 2019. Appendix C provides a sample of the survey and all its questions. Twenty-seven businesses responded to the survey; however, some of the questions did not receive responses from all participants. While there are 29 responders listed in Appendix C but there are only 27 businesses represented because two businesses responded twice. We provide results in both total responses and percentage of responders to each question considered. Some questions resulted in varied or non-applicable answers and were therefore not considered in this section but are included in Appendix C.

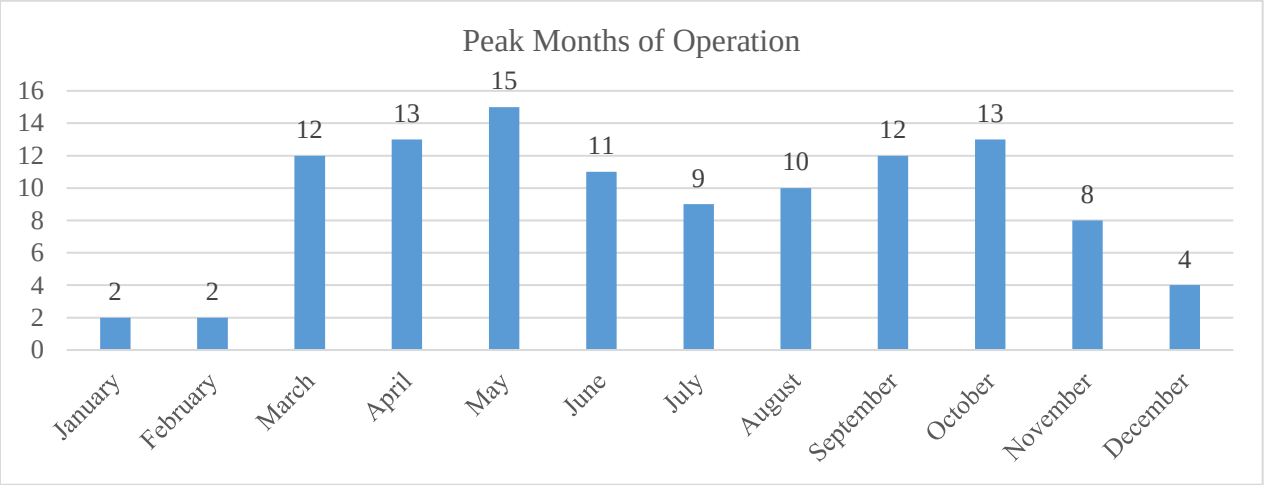
The first survey questions considered are age of business, years under current management, and years under current ownership. Most businesses fell between 1-55 years of age, with an outlier, German American Bank, with an age of 109 years. Table 8 shows a summary of ranges for each question, indicating that the majority of responding businesses fall in the document 1-15-year range for all three questions.

Table 8: Business Stakeholder Survey Age Demographics. Source: Capstone 2019.

	1-15 years	16-30 years	31-45 years	45+ years	Total Responses
Age of Business	11 (48%)	6 (26%)	3 (13%)	3 (13%)	23
Years Current Management	19 (73%)	5 (19 %)	2 (8%)	0	26
Years Current Ownership	18 (69%)	6 (23%)	2 (8%)	0	26

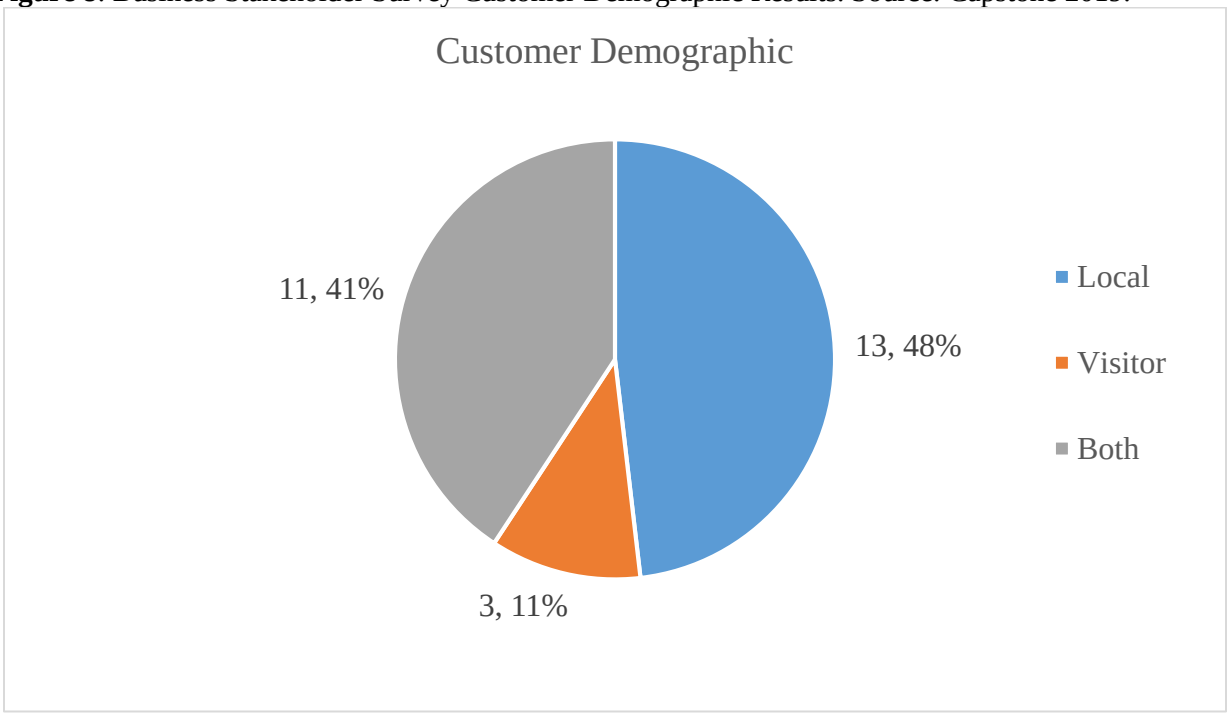
Responses for type business ranged over 17 categories. Four responders fell under hotel/inn, four fell under real estate, two under building/construction, two under product sales, and two under senior care. Other responses indicated business types including a store, museum (nonprofit), art studio, marketing, repair, bank, catering, telecommunications, travel, alterations, college planning, and human services (nonprofit). All responding businesses are based in Monroe County, besides one online store based in Daviess County. Twenty responders (77%) were locally owned, five (19%) were non-locally owned, and one responder was unsure. Twenty-six (96%) of responders operate year-round, and 1 is a seasonal summer business. Businesses responded with ranges for peak months of operation, as described by Figure 7, excluding the six responses that indicated all year.

Figure 7: Business Stakeholder Survey Peak Months of Operation. Source: Capstone 2019



Fifteen of twenty-six responses (57.7%) indicated that Lake Monroe affects their business. Of those 15 responses, nine (60%) indicated the cause was tourism/visitors, two (13%) indicated the cause was aesthetic values, and five (33%) indicated indirect or other impact. In response to the benefits businesses received from Lake Monroe, eight responders (50%) indicated visitor business, four (25%) indicated homes and property sales, one indicated drinking water, one indicated marketing, and three indicated other or indirect benefits. Of 21 responses, 16 (76%) of businesses said their customers and clients value the lake for recreation, and five (24%) said for aesthetic purposes. A majority of businesses, 13 (48%), indicated their customer or client base is mainly local residents, three (11%) indicated mostly visitors, and 11 (41%) indicated a balance between both categories (Figure 8).

Figure 8: Business Stakeholder Survey Customer Demographic Results. Source: Capstone 2019.



Only seven of 27 (26%) responding businesses offer activities or events involving Lake Monroe to their customers and clients. Activities include boating, hiking, fishing, camping, music, food, camping, and beach access. Responders listed many activities or amenities they wished to see at Lake Monroe, including more food options, senior activities, clean water, more bathroom and dock access, guided boating and hiking tours, and more transportation options for the park areas. Recommended improvements included seven (47%) responses for cleanup and trash problems, three (15%) for more shopping and dining options, two for more activities, two for improved access, and one for improved facilities. Of 15 responses, 11 (73%) businesses indicated their water source was Bloomington city water, two (13%) source from Monroe County, one from East Monroe Water Company, and one from Shady Side Water Corporation.

3.4 Setbacks

Time was a major limiting factor for our group's productivity. Without prior, deep-rooted connections to an organized list of stakeholders, we experienced many delays in acquiring data due to lack of response from stakeholders, which were problematic during our short project timeline. Additionally, while conducting the survey local businesses expressed a lack of willingness to share revenue data. Thus, we were unable to initiate a study which examines how Lake Monroe presence, or condition, is associated with revenue generation. While the USACE has been very cooperative, it took several weeks, emails, and other points of contact to discover that Fast Facts Sheets created prior to 2016 would not be available, or if they were, they would not be accurate due to an overhaul in visitation data. We also had delays when contacting the IDNR for boating licenses and registration.

In the final month of our project timeline it was suggested that we adjust our data to account for marginal hedonic values of revenue. We consulted Dr. Nikolaos Zirogiannis, an assistant scientist in environmental economics and policy issues at the O'Neill School of Public and Environmental Affairs. We received advice on the concept but were told that research in this topic is lacking and given recommendations for finding literature. We were unable to find a comparable study or relevant revenue data to follow through with producing our own study. The lack of long-term relationships may have influenced the unwillingness among most businesses to share past revenue data with our group via our survey. Our group was unable to access revenue data on online databases that required membership, as well as unable to interpret revenue from incomplete online database profiles of businesses that responded to our survey.

3.5 Conclusion and Recommendations

The quantitative and qualitative data we have gathered illustrates that Lake Monroe is valued highly and by many different people. Businesses, state organizations, recreationalists, and many others all rely on Lake Monroe. The presence of Lake Monroe generates business, wages, tax revenue, and leisure opportunities all which impact Bloomington and the surrounding area. Stakeholder reports from VB and USACE agreed Lake Monroe generates around $20 million dollars annually in recreational value and around $8 million dollars annually in labor and workforce value. According to the business stakeholder survey, over half (57.7%) of responding business indicated that Lake Monroe affects their business.

Due to the symbiotic relationship between Lake Monroe and many local businesses, the Greater Bloomington Chamber of Commerce has stated their genuine desire to cooperate in order to keep Lake Monroe clean. Thus, moving forward, we recommend that FoLM strengthen and maintain a relationship with the Greater Bloomington Chamber of Commerce. We recommend FoLM establish a relationship with the USACE to motivate the continued annual publication of Fast Facts Sheets for recreation and water supply. Similarly, FoLM should seek annual economic impact surveys from the IBFL, or at the very least attendance records, which could be combined with a multiplier.

If FoLM is interested in conducting a hedonic pricing study to compare water quality to business revenue, the model will require supplemental data. We recommend FoLM collect historic revenue data using IRS filings for larger public companies via the Securities Exchange Commission website. Lastly, FoLM should continue to partner with the Lake Monroe Watershed Coalition to maintain a mutually beneficial relationship promoting lake and watershed best management practices. This partnership would help maintain the Lake for current and future stakeholders who each bathe in the benefits provided by Lake Monroe.

4. Economic Valuation: Ecosystem Services

4.1 Introduction

This section looks more closely at what may constitute an ecosystem service, presents general values created by meta-analysis studies that have been widely accepted by the scientific community, and offers insights to how these services may (or may not) apply to Lake Monroe and possible future studies.

4.1.1 Definition and Classification of Ecosystem Services

Ecosystem services are defined as the products or interactions of an ecosystem that humans derive some benefit from, be it direct or indirect (Costanza et al., 1997; Costanza et al., 2014). The number of ecosystem services provided by an area of study, region, or biome is limited by the understanding of system interactions, time, manpower, and cost. Classifying services can be arbitrary and caution should be observed when selecting ecosystem services for closer study. We used Costanza et al. (1997), Costanza et al. (2014), and de Groot et al. (2002) classification systems due to wide acceptance by the scientific community and the manageable number of classification of services for the scope of this particular study.

The following ecosystem services will be defined and explored, based on the Costanza et al. (1997), Costanza et al. (2014), and de Groot et al. (2002): Biological control, climate regulation, cultural benefits, disturbances regulation, erosion control, food production, gas regulation, genetic resources, human health, nutrient cycling, pollination, raw materials, and species refugia.

4.1.2 Service Eliminations and Caveats

Ecosystem services that are not included are recreation and water quality/waste treatment. This is due to the extensive research led by the other groups, on the grounds that these two services provide accessible and quantifiable data that will result in an economic value specific to Lake Monroe.

This decision reveals a challenge presented by valuing ecosystem services: their ambiguity and interrelated nature. It is for this reason that it was recommended to use a literature review and aggregated data to provide an overall picture of how much ecosystem services may be worth, while pursuing more quantifiable services that were possible given the scope, time, and data available for this project.

4.1.3 Purposes of Exploring Other Services

While recreation and water quality are functions of Lake Monroe that have measurable indices and relatively accessible data, the other functions served by this ecosystem are more ambiguous in nature, but no less valuable. It is important to have an introduction to these other functions, both for engagement purposes and to identify possible areas of future projects regarding Lake Monroe.

4.1.4 Purposes of Literature Review

For the purposes of this area of study, we used literature reviews to obtain overall ranges for various ecosystem services potentially provided by Lake Monroe. With more time and research individual services can be identified and studied in more detail. A basic knowledge of ecosystem services and the role they play in human benefits is necessary before applying and exploring them

in the context of Lake Monroe. Because of the extensive collection of data, and the overall acceptance of the scientific literature community, we relied mainly on the information and data provided by Costanza et al. (1997), Costanza et al. (2014), and de Groot et al. (2002). A literature review of the economic values of protecting the Great Lakes by Marbek (2010) provided recent data that was more attributable to a freshwater inland body of water such as Lake Monroe.

Different valuation needs call for different methodology approaches. Education and awareness outreach, which is the main goal of this section, has low precision of aggregate values (Costanza et al., 2014). For this reason, we recommend not using an area multiplier on these values, as they do not accurately represent values specific to Lake Monroe.

For observing potential land use or ecosystem changes (in this scenario the "greening" of Lake Monroe), regional to global scales with estimated total value and macro-aggregates are the most useful elements for education purposes (Costanza et al., 2014). Using these values is especially helpful when it is not financially and temporally possible to extrapolate the values specific to the area of study.

Costanza et al. (1997) used a variety of valuation studies in order to develop total values multiplied over ecosystem areas and was one of the first global estimates for ecosystem services. It achieved the goal of creating greater awareness and the data used to create aggregate values were consolidated using basic benefit transfer, an approach which assumes a constant value per hectare of ecosystem type. It then takes that value and multiplies it by total area to create a single value. This method overlooks the complexities within separate ecosystems but remains a useful tool for outreach as well as studying and assessing land use change scenarios. It is a helpful resource and tool for researchers and policy makers who have to balance time and budget constraints (Costanza et al., 2014).

The authors of de Groot et al. (2002) updated the values obtained from Costanza et al. (1997), and added an analysis of the type of valuation method used to create the multiplier values. By doing this, de Groot et al. (2002) revealed the most common types of valuation methods used for specific types of ecosystem services.

The final study used for current data was a valuation study conducted in 2010, creating a total value of protecting the Great Lakes. The Economic Value of Protecting the Great Lakes (2010) used a literature review to develop a list of ecosystem services provided by the lakes the associated values of maintaining high environmental quality of the region (Marbek, 2010). The study provided additional values that were lacking in Costanza et al. (1997), Costanza et al. (2014), and de Groot et al. (2002). It provides several methodologies for identifying and measuring ecosystem services and communicates the challenges associated with applying a monetary value to them. Because the study focused on the lake ecosystem itself, it provided more specific values to include in the final deliverable.

These studies provided the basis for the creation of the final deliverable. They contain recent data and provide dataset collection sites where additional cases for individual studies can be located. For these reasons the data presented in Table 9 were adapted from these studies. The process used to select, modify, and communicate the values is discussed in the methodologies section.

The following section will explain the methodology of acquiring data from these and other resources, a more detailed explanation of the services explored and data found, an explanation of the resulting data table, and will conclude with final thoughts, lessons learned, and ideas for potential future studies of ecosystem services provided by Lake Monroe.

4.2 Methods

No research currently exists evaluating the economic value of ecosystem services specific to Lake Monroe. After consultation with O'Neill School faculty, we determined that (1) a contingent valuation is necessary to collect specific values for Lake Monroe and (2) a comprehensive literature review is the best alternative given time and information constraints. Compiling data from literature and other case studies will provide a range of values that these ecosystem services can be valued at short of a contingent valuation study.

The values for this report were gathered from a comprehensive literature review of similar case studies. We compiled the values from other case studies into a metadata sheet (Appendix D) and then provided a summary of the minimum, maximum, and median values in Table 9. The compiled case studies were from various lake-based ecosystems around the globe. Many of these cases used Costanza et al. (1997) or de Groot et al. (2002) as a basis for collecting area specific data. These values have been adjusted for 2019 inflation and international currency exchange rates at the time the studies were completed.

Lake Monroe's watershed consists of lake, wetland, and wooded ecosystems. The values in Table 9 lump values for these three ecosystems to provide a collective value. The meta-data sheet shows a breakdown of these individual ecosystem values per ecosystem function. The definitions for the ecosystem services are primarily based on Costanza et al. (1997) and de Groot et al. (2002) with some changes to match the purposes for Lake Monroe.

4.3 Results

4.3.1 Ecosystem Functions

4.3.1.1 Biological Control

Biological control is the trophic-dynamic regulation of populations. Examples include keystone predator control of prey species and reduction of herbivory. There are many examples of using the introduction of species to control other population levels. Biological control is frequently employed to control pests and curb overgrazing from herbivores in agricultural, urban, and natural resource management settings. It is difficult to apply a monetary value to a baseline trophic chain in an ecosystem.

We gathered the minimum and maximum values for biological control from de Groot et al. (2002). The $3.14-122.3 per hectare per year range represents a replacement cost, which is the amount that someone would have to pay to substitute an ecosystem service. The second number ($1150.87 per hectare per year) represents a meta-analysis of gathered data. The sizable gap between the two values reflects the varying trophic relationships that exist between species. Ecosystems support a wide variety of animals, and therefore different systems will have different values based on the baseline species richness of the area and the trophic relationships that exist within them. It will

also depend on the scale of the ecosystem being considered – the larger the area, the more complex the trophic chain is likely to be.

4.3.1.2 Climate Regulation

As climate change continues, increasing attention must be paid to how ecosystems work to regulate fluctuating weather patterns. Obtaining monetary values for climate regulation services has high transaction costs and requires extensive research of historical meteorological data as well as accurate current information regarding how the ecosystem currently influences the local climate. For this reason, there is a wide range of possible costs of climate mitigation. The climate regulation values were taken from de Groot et al (2002).

We defined climate regulation as the regulation of global temperature, precipitation, and other biologically mediated climate processes. Examples include greenhouse gas regulation (*i.e.*, carbon dioxide sequestration) and dimethyl sulfide production affecting cloud formation. Although normally on a regional or global scale, some research finds that microclimates – the climate close to the ground – can be impacted by land cover and land uses (Rosenberg, Vlad, & Verma, 1983).

Microclimate indicators around water can include temperature, humidity, and precipitation, and provide a more favorable or unfavorable environment for human benefits. However, the regulators of microclimate (forest type and evaporation) are connected with other ecosystem services, and therefore it is difficult to disaggregate the value of an ecosystem's influence specifically on climate. Therefore, data from de Groot et al (2002) provide a minimum of $8.50 and a maximum estimate of $492 per hectare per year. The values come from a meta-analysis of climate regulation studies based on wetlands and woodlands.

These values have a sizable range, reflecting the ambiguous nature of this service: it is difficult to attribute the weight an ecosystem plays in the role of climate regulation, revealing the need for more research regarding this service, especially for lake ecosystems.

4.3.1.3 Cultural Benefits

This ecosystem function relates to the non-consumptive uses of ecosystems. This function includes a variety of natural features that hold spiritual, historical, educational, aesthetic, or artistic values. People enjoy the landscapes and scenery of natural areas, which have considerable economic values. For example, wildlife-watching in a natural area is a non-consumptive use of an ecosystem that holds economic value. Natural ecosystems also have artistic values as they are sources of inspiration for books, movies, photography, paintings, and more. Nature is constantly used for these purposes, but an economic value is rarely put on this service. Finally, natural ecosystems provide opportunities for educational enrichment through environmental education and studies that lead to publications, which is also a service that is rarely priced.

Lake Monroe holds a cultural value, as its scenery and landscapes ameliorate the lives of residents living nearby the lake, or of transients visiting the lake area. People also enjoy the aesthetic information the lake conveys when they watch wildlife near the lake. Furthermore, the lake is used for a multitude of excursions, including school field trips or watershed tours, which provide people with educational enrichment.

The Great Lakes report showed that wildlife watching brought from $3.53 to $240.92 per wildlife watching day. Wildlife watching refers to the value placed on this activity by those who undertake it and the economic benefits to the local economy that result from this activity. Estimating wildlife watching benefits relies on the travel-cost method, which calculates the cost associated with trips to watch wildlife. Studies also rely on participants' willingness to pay for wildlife-watching. The $3.53 to $240.92 consumer surplus per wildlife-watching activity per day can therefore be a good estimate of the cultural benefits function lake ecosystems hold. However, this range is not specific to Lake Monroe and does not take into account other spiritual, historical, educational, or artistic value a lake ecosystem can hold. Furthermore, Hanson et al. (2002) found that contingent valuation survey participants were willing to pay $26.26 per year to preserve reservoirs for future generations.

4.3.1.4 Disturbance Regulation

This ecosystem function relates to the ability of ecosystems to dampen environmental fluctuations. It includes storm protection, flow and flood control, drought recovery, and habitat responses to environmental fluctuations that are mainly controlled by vegetation. For example, vegetation can mitigate the effects of storms, floods, and droughts through its water storage capacity. The ecosystem services provided by this function impact humans by mitigating the effects of disruptive natural events and hazards, thus providing safety for humans and structures.

Lake Monroe's vegetation (trees and plants near water line) provides storm protection and flood control by mitigating environmental hazards such as storms or floods through its water storage capacity. Lake Monroe also provides flood control by raising its water table, thus avoiding damages to nearby structures and parcels.

The Great Lakes report found that disturbance regulation could be valued between $378.61 and $11,398.36 per hectare annually. These values arise from replacement cost or avoided cost methods. The replacement cost method estimates the infrastructure costs that would be needed to replace flood control offered by a natural vegetative cover. The avoided cost method estimates the economic damages that would incur without flood control by a vegetative cover. The range found in the Great Lakes Report can be used as an estimate of the disturbance regulation function of Lake Monroe. However, it doesn't take into account Lake Monroe's specific characteristics, frequency of flood events, capacity to raise water table or absorb excess water, and property values of surrounding areas.

4.3.1.5 Erosion Control

This ecosystem function relates to the role vegetative cover plays in soil retention, reservoir fill-in, and the prevention of landslides. It includes the prevention of soil loss by wind, runoff and other ecological processes, and the prevention of the storage of stilt in lakes and wetlands. For example, tree roots stabilize soil and prevent erosion of bare soil. Plants and submerged vegetation control erosion and facilitate sedimentation. The ecosystem services provided by this function prevent damages due to soil erosion.

Lake Monroe's watershed contains forests and wetlands that contribute to erosion control. Moreover, the vegetative cover and root system along the riparian zone and shoreline of Lake

Monroe, as well as submerged vegetation near its shoreline, help control erosion and sedimentation.

De Groot et al. (2002), found that erosion control could be valued between $6.07 and $3164 per hectare per year. These values take into account wetlands, temperate forest, and woodland values. No value was reported for lake ecosystems themselves. This range can be used as an estimate of the erosion control function that Lake Monroe and its watershed hold. However, the range is not specific to Lake Monroe, and these values could differ if forests and wetlands actual areas, as well as vegetation types, were taken into account for valuation.

4.3.1.6 Food Production

Food production in generic terms is the production of flora and fauna for human consumption such as fish, game, and crops. Fish and game are the primary foods produced in the Lake Monroe ecosystem. Common fishing species in Lake Monroe include largemouth bass, channel catfish, white crappie, walleye, and bluegill (All About Fishing, 2017). Largemouth bass, in particular, is very popular for fishing at Lake Monroe, and the lake has hosted bass fishing competitions in the past. Game found in the watershed includes white-tailed deer, wild turkey, rabbit, and various waterfowl (DNR, 2019). Lake Monroe provides essential habitat for fish and game and other flora and fauna that might be consumed by humans. The value for food production ranges from $63.13 to $745.40 per hectare based on de Groot et al. (2002) for lakes, wetlands, and wooded ecosystems.

4.3.1.7 Gas Regulation

Lakes and reservoirs like Lake Monroe can help regulate chemical balances in the atmosphere and remove gases like ozone. Improving air quality is an important benefit for both residents and tourists. Human-induced air pollution can have adverse impacts on human health.

Bloomington's region is in attainment for ozone, but ozone levels become elevated during summer months and can affect sensitive groups (Bloomington Environmental Commission, 2001). A healthy Lake Monroe can mitigate this issue by providing an ozone sink.

The Great Lakes Report showed a range of $477.53 to $1186.99 per hectare for gas regulation. This value was estimated by calculating the economic losses due to air pollution within the watershed. A similar method could be applied to Lake Monroe and counties within the watershed given more time and resources.

4.3.1.8 Genetic Resources

The benefits an ecosystem gains from genetic resources relates to the conservation of strong genes, protection from pests and disease, improvement to taste, and strengthening cultivated agriculture. This is a complicated function to understand but it can occur through cross-breeding, extensive cultivation, and manipulating the environment.

For this service, we took the values from de Groot et al (2002) to gain an estimate for Lake Monroe. Our minimum value is $3.64 per hectare per year, a median value of $1046.47 per hectare per year, and a maximum value of $1475.95 per hectare per year.

4.3.1.9 Human Health

The value obtained for human health represents potential costs added due to exposure to algal blooms. The study used was conducted by the Environmental Protection Agency that focused on the overall economic influence of nutrient runoff (EPA, 2015). Increasing algal blooms leads to more exposure via ingestion, inhalation, and skin contact. Because some algae can negatively impact health through the production of toxins, diseases as a result of this exposure can lead to the need for medical intervention, accruing costs for both the individual and society. As outbreaks become more common, visitation to the ecosystem area may decrease and affect the benefits provided by the services.

The greatest challenge in calculating any kind of health costs related to algal blooms in freshwater is a lack of data. Most studies currently focus on coastal algal blooms and health effects related to shellfish consumption in addition to recreational exposure. The Center for Disease Control has developed a voluntary system – the One Health Harmful Algal Bloom System – as an opportunity for local health services to identify and catalog health issues directly related to algal bloom exposures (CDC, 2019). While this could help single out freshwater bloom exposures to help configure a more specific health cost monetary value, it is a recent development and currently does not provide that specific data. Therefore, the values used represent coastal data and were developed using emergency room visits, taken from an Environmental Protection Agency Nutrient Economics Report. An estimated $130,000 was spent on increased emergency room visits due to respiratory complications caused by algal bloom exposure between the years of 2010-2012 (EPA, 2015). This data is particularly useful because the ER visits were due to inhalation exposures of algal bloom toxins, which more likely to occur in a freshwater reservoir like Lake Monroe than ingestion via shellfish.

The study data was obtained from the coastal county of Sarasota, Florida, and therefore caution must be observed in its application to Lake Monroe, due to the differences in location and nature of the bloom. However, there are substantial health costs associated with algal blooms and healthy aquatic ecosystems may help mitigate those costs.

4.3.1.10 Nutrient Cycling

Nutrient cycling is defined as the storage, cycling, processing, and acquisition of nutrients, and the role biota play in this cycle. Nutrients can be elements that are considered essential for the growth and development of living organisms (MA, 2005). Key nutrients that are commonly under study are phosphorus (P), nitrogen (N), carbon (C), and sulfur (S), and the cycles they are a part of. This may include N fixation from the atmosphere to the soil or P loading into a water ecosystem, or C sequestration through the storage of carbon dioxide in trees or the ocean. All of these processes affect the flux of these elements in local and global ecosystems.

In preindustrial times, the nitrogen flux from the atmosphere to the land and oceans was approximately 90-130 Tera grams/year. Since the industrial revolution, however, it has increased to 200 Tera grams/year, and is no longer balanced by denitrification, the process by which nitrogen is returned to the atmosphere (MA, 2005). This increase in flux is a result of the development of synthetic nitrogen fertilizers and increased air pollution. Besides the global nitrogen cycle being out of balance, the same holds true for local agroecosystems due to the development of nitrogen

fertilizers. While the use of these fertilizers has increased food production, it has come at the cost of excess nitrogen accumulating in ecosystems, disrupting the balance of organisms and diminishing the value of other ecosystem services.

Phosphorus before the industrial era entered the environment at a flux rate of 1-6 Tera grams/year; post-industrialization it now has a rate of approximately 10.5-15.5 Tera grams/year. Like nitrogen, people mainly use phosphorus as a fertilizer in agriculture, is added to the existing soil in increasing loads, and eventually washes into waterways. Phosphorus proves particularly challenging to reduce because its transport into water is slow and difficult to prevent (MA, 2005).

Because of its recent analysis and use of a large available dataset, the average values per hectare for nutrient cycle ecosystem service were taken from de Groot et al (2002). The values developed in de Groot et al. (2002) were obtained predominately from replacement cost valuation studies. Once adjusted for inflation, the values found for this service ranged between $112.90 and 2079.58 per hectare per year. This range is a result of the different roles specific nutrients might play in an ecosystem, the proximity to human populations for cycling to affect, or the availability of biota to affect and manage this process.

Balanced nutrient cycling is essential to the maintenance of ecosystem services, and other ecosystem services influence this cycle – once again, the caveat of interconnectivity remains in placing a monetary value on this particular service. The weight one places on this service may be influenced by bias, and it could be difficult to disseminate the true value of nutrient cycling from that of other services. However, nutrient cycling plays a vital role in regulating ecosystem services that indirectly affect human benefits and health, and thus further study of this service is warranted.

4.3.1.11 Pollination

The role pollinators fill is to move gametes or pollen across plants to facilitate new growth. Pollinators include bees, birds, natural forces, and other modes of transport. Our value for pollination came from the Costanza et al. paper, and we only gathered a single value. We were unable to locate other solid research for estimates regarding this service but chose to still include it because pollination is required for a healthy lake system, and spills into the surrounding area to create a healthier ecosystem.

Indiana is a state that relies heavily on agriculture, so the roles that pollinators play can be very important. Aside from agriculture, pollinators aid in keeping plant ecosystems healthy, growing, and thriving. From Costanza et al.'s (1997) and Costanza et al.'s (2014) research, it is estimated that the value of pollination is $37.63 per hectare per year. More research would need to be done to learn what kind of pollinators are active around Lake Monroe, and how much plant life in the area relies on pollinators to move its pollen around and continue growing. You may also need to consider other threats to pollinators and what dangers they face, as that could influence the monetary value placed on pollination.

4.3.1.12 Raw Materials

Humans use a variety of materials that come from nature, including lumber, fuel, fodder, stone, and limestone. These are used in both their raw form and converted into other materials, depending on the use.

Our range of values came from the de Groot et al. (2002) paper, and displays values found in wetlands, woodlands, and temperate forests, as these are the habitat types found in the Lake Monroe watershed. We combined these three habitat types into one set of values, with the minimum being $206.38 per hectare per year, the median $219.73 per hectare per year, and the maximum $515.95 per hectare per year. You can find specific numbers on each habitat type within Appendix D, under the "Raw Materials" section.

A more precise number for Lake Monroe could be found by looking at the types of raw materials that are currently being extracted or gain a potential value by looking at the resources the lake has and calculating a value from that. However, it is important to note that removing raw materials from the ecosystem now removes the service this resource was previously providing, like climate regulation with trees, the filtering properties limestone has, or a tree stand acting as refugia. This service is a trade-off with these and many others, and in order to learn which areas would be suitable for harvesting a habitat assessment would need to be done.

4.3.1.13 Refugia

Habitat that acts as a suitable living space for animals and plants, including vital habitat types like nursery habitat, migration paths, or wintering grounds, are considered refugia. This service is vital to the success of an ecosystem, helping bring balance to the area, provide necessary habitat that is linked to other services, and enhances an area.

Our range of values comes from the TEV framework used by the Great Lakes report: a minimum value of $325.18 per hectare, a median value of $3760.625 per hectare, and a maximum value of $7196.07 per hectare. In our supplemental information you can also find a contingent valuation (CV) study done by Hanson et al. on what a community would be willing to pay per year to keep refugia safe in their reservoir. A repeat of a similar CV study could be done within the area to determine a value for Lake Monroe. You would need to include local examples about animals and plants in the area that benefit from refugia specifically in Lake Monroe: fish species in the lake, birds that migrate overhead, or animals in the woodland area. This could help those surveyed better understand what might be at risk if the Lake's ability to act as refugia was diminished or gone entirely.

4.3.2 Data Sheet

Table 9 (pages 38) is organized by ecosystem function. The table includes (1) the definitions we developed for ecosystem functions by looking at various resources; (2) a non-exhaustive list of examples for the lake ecosystem; (3) the minimum, maximum, and median values; and (4) the units. We created Table 9 to give a snapshot of potential ecosystem service values, to allow for easy estimation within the Lake Monroe watershed. A compilation of all values used can be found in our metadata table in Appendix D.

To supplement Table 9, we have included the datasheet that we pulled our range of values from. This sheet is organized by ecosystem service, and includes the original value we found through research, an inflation rate, the 2019 value after adjustment for inflation, all of the high and low values found on Table 9, other values that went into finding the median, supplemental values that we thought were important to consider when looking at an ecosystem service, but were difficult to

combine with other data, the source for each value, and methods used to find the value if given. We have included this data to complement Table 9, and to have a compiled place that holds all of the data used in our report.

To create this datasheet, we completed extensive research on ecosystem services individually and compiled them into one Excel file. Once we had finished researching, we went through the sheet line by line to assess the validity of the data found and its relevance to Lake Monroe. We removed any values that we felt did not meet these criteria and would continue to do so throughout the rest of the process. Once our data was sorted and parsed down, we converted and inflation-adjusted all values to 2019 US Dollars. We assessed the datasheet and decided what values to add to Table 9, what values to remove, and what values keep as useful supplemental information in Appendix D.

4.4 Recommendation for Future Study

Our case studies reflect ecosystem services values that do not directly come from Lake Monroe's economic evaluation. These values are to be used as an estimate of the ecosystem services value that Lake Monroe provides. Although these values can be applied to Lake Monroe, a contingent valuation study is required in order to obtain Lake Monroe specific numbers. Implementing a contingent valuation study was however out of our capabilities. The following section drafts such a study that could be refined and implemented by FoLM in the future.

Ecosystem Function	Definition	Ecosystem Examples	Min Value	Median Value	Max Value	Unit
Biological Control	Trophic-dynamic regulations of populations	Keystone predator control of prey species, reduction of herbivory by top predators	3.14	122.33	1150.87	2019 USD/ha*year
Climate Regulation	Influence of land cover and biological mediated processes on local climate	Greenhouse gas regulation, DMS production affecting cloud formation	8.50	300.465	592.43	2019 USD/ha*year
Cultural Benefits	Variety in natural features with cultural, spiritual, historical and artistic value	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems	3.53	122.225	240.92	2019 USD/wildlife watching day
Disturbance Regulation	Influence of ecosystem structure on dampening environmental fluctuations	Storm protection, flood control, drought recovery and other aspects of habitat response to environmental variability mainly controlled by vegetation structure	378.61	5888.485	11398.36	2019 USD/ha
Erosion Control	The role vegetative cover plays in soil retention, reservoir fill-in, and the prevention of landslides.	Prevention of loss of soil by wind, runoff, or other removal processes, storage of stilt in lakes and wetlands	6.07	15.78	3164.90	2019 USD/ha*year
Food Production	Production of flora and fauna for human consumption	Production of fish, game, crops, nuts, fruits by hunting, gathering, subsistence farming, or fishing	63.13	245.835	745.40	2019 USD/ha*year
Gas Regulation	Role of ecosystems in bio-geochemical cycles	CO2/O2 balance, O3 for UVB protection, SOx levels	477.53	832.26	1186.99	2019 USD/ha
Genetic Resources	Genetic material and evolution of wild plants and animals	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pests and horticultural varieties of plants)	3.64	1046.47	1417.95	2019 USD/ha*year
Human Health	Impact on public health from ecosystem exposure	Increased number of ER visits for respiratory reasons, reported cases of human illnesses and dog deaths	23022.30	87155.85	151289.40	2019 USD/year
Nutrient Cycling	Role of biota in storage and cycling of nutrients	Nitrogen fixation, Nitrogen, Phosphorus, and other elemental or nutrient cycles	112.9	1096.24	2079.58	2019 USD/ha*year
Pollination	Movement of floral gametes	Provisioning of pollinators for the reproduction of plant populations	37.63	37.63	37.63	2019 USD/ha*year
Raw Materials	Production of materials for human use and conversion	The production of lumber, fuel, or fodder	206.38	219.73	515.95	2019 USD/ha*year
Refugia	Suitable living space for wild plants and animals	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or overwintering grounds	325.18	3760.625	7196.07	2019 USD/ha*year

5. Contingent Valuation Study

5.1 Introduction

Contingent valuation (CV) is a survey-based method to value goods, typically used for non-market or non-observable values associated with the good (Carson, 2000). Contingent valuation techniques are commonly employed for environmental services and amenities, as you may not be able to directly observe the monetary value individuals place on passive use benefits like the ability to swim in a lake or observe wildlife. Contingent valuation is often referred to as a stated preference approach, due to participants being asked to state their preferences or willingness-to-pay for a given scenario or good.

A CV survey typically consists of a realistic hypothetical scenario and questions about the individual's response to the scenario. Respondents are asked questions about their willingness-to-pay (WTP) or willingness-to-accept (WTA) a dollar amount for a given change in the quality or availability of a good. Generally, WTP measures how much individuals would be willing to pay for an improvement or increase in access to a good, and WTA measures how much individuals would accept to forgo a given level of a good. A CV survey supplements the other valuation techniques used in our report by providing a method to include passive and non-use values to the overall valuation.

Contingent valuation surveys can illicit economic values through a variety of survey instruments, such as open-ended or dichotomous choice questions. CV surveys can be implemented using mail-based, phone-based, web-based, in-person, of mixed survey modes. These survey instruments and modes are discussed further in Appendix K of this report.

The selection of survey instrument, mode, geographic scope, and other CV design elements are interconnected because all the elements affect the possible sample size and necessary materials in interrelated ways. To adjustment surveys design, researchers should make decisions aware of the connections between choices and the impact on their budget constraints.

5.2 Implementation Methods

Taking into consideration the limited funds, time, and workforce of FoLM, we recommend the following study design to determine the regional and county-specific willingness-to-pay of county residents for the ecosystem services of Lake Monroe. For specifics and explanations regarding underlined terms in this section, see Appendix K.

Because some revealed preference methods require intensive, expensive, and potentially impossible data gathering, we recommend a stated preference method, which determines the degree to which respondents *say* they value Lake Monroe. We have drafted a contingent valuation survey (Appendix E) with a double binary discrete choice design. This design, as we implement it, uses the following steps:

1. Present the respondent with a scenario of change to Lake Monroe water quality and its related impacts on recreational opportunities;
2. Ask each respondent whether they would be willing to pay (yes or no) a randomly selected willingness-to-pay (WTP) value from a pre-determined range of WTP values;

3. If the respondent responds positively, ask the respondent if they would be willing to pay double the presented WTP value; and
4. If the respondent responds negatively, ask the respondent if they would be willing to pay half the presented WTP value.

Though the survey will collect will collect double binary discrete choice data, we have only provided the data analysis methods to analyze the data for the first step of the discrete choices; modeling the double binary discrete choice to calculate WTP is virtually impossible in SAS or STATA and is very complicated to model in R (David Good, personal communication, 23 April 2019). If FoLM wants to use the additional data provided by the double binary discrete choice, we recommend hiring a professional data analyst. The calculation based on a single binary discrete choice will still be valuable and potentially accurate; the double question simply allows researchers to gether more data from each respondent, shrinking the standard error of the results.

Well-designed CV surveys typically control for error or bias in the pre-determined range of WTP values by studying the literature for similar situations, adapting the range of values used in that literature for their situation, and implementing a series of pilot surveys to adjust the WTP range to appropriately fit the target population. Because pilot surveys multiply the expense and time demands of a CV survey design, we opted instead to review literature on CV surveys for similar situations, select a wide WTP value range based on that literature, and use larger increments between WTP values.

For this CV survey, we recommend using a WTP range of $10 to $250 in increments of $40 (*i.e.*, the values of $10, $50, $90, $130, $170, $210, $250), to be paid over a five-year period. We recommend this specific WTP range based on a variety of values in the literature (Azevedo et al., 2001; Lipton, 2004; Ramajo-Hernandez and Saz-Salazar, 2012; Stumborg et al., 2019). Because this WTP range is wide and the steps between increments are large, the results of this CV survey will be less precise. Because of the limited resources of FoLM, we believe the loss to precision is worth the saved expense/time; however, if FoLM wants to increase the precision and accuracy of the WTP estimates the CV produces, FoLM should implement pilot studies, as discussed in Appendix K.

Because of FoLM's interest in the preferences of residents distinguished by county, we recommend a three-county sample frame (Brown, Jackson, and Monroe counties) rather than a statewide or buffer area sample frame. While a statewide sample frame would capture values of Lake Monroe held by Indiana residents outside the immediate area that travel for recreation, the costs of implementing a statewide study would be enormous due to the large sample size. Conversely, a buffer area sample frame would be more affordable, but would not sample from the full area of the counties of interest.

To sample the selected three-county sample frame, we recommend the use of stratified random sample design through address-based sampling. Properly-executed random sampling of any variety eliminates bias, allows for generalizations to the full population, and allows for causal claims; however, random sampling is more labor and resource intensive than non-random sampling techniques. Stratification allows the researcher to generalize the results to the stratum of

interest. Because FoLM is interested in having results specific to the three counties of interest, we recommend random sampling stratified by county.

Address-based sampling uses an address database acquired through a vendor, which usually captures close to 100% of possible respondents in the sample frame (Link et al., 2008). Other random sampling techniques (like random digit dialing) collect samples that are less representative of the sampled population. Convenience sampling techniques (like surveying people at a convenient location or emailing a survey link to community groups) produce results biased in uncontrollable ways. Because the cost to implement address-based sampling may not be significantly larger than biased sampling methods, we strongly recommend the use of random address-based sampling.

We recommend a sample size of 1000-1200 individuals from each of the three counties of interest for a total sample size of 3000-3600. For calculations and discussion of the strengths and weaknesses of various sample sizes, see Appendix K.

While the best method for sample implementation to increase representativeness and reduce bias is in-person interviews, in-person interviews are cost and time prohibitive for FoLM. We therefore recommend the use of a mail-based survey. By sending physical copies through the mail with pre-paid return postage, mail-based surveys increase the representativeness of the survey compared to web-based surveys (Appendix K). The version of the CV survey we have drafted is optimized for print distribution; if FoLM decides to distribute the CV survey via the internet, the survey would need to be re-designed to optimize for web access.

Below is a step-by-step guide to survey implementation, assuming a sample size of 3,600 total surveys (1,200 per county).

1. Address acquisition (purchasing through vendor or GIS-based)
    a. Marketing Systems Group is a private vendor that will acquire addresses for FoLM. Call 215-653-7100 and ask to speak to Raj – he provided the quote for the budget. Request 3,600 addresses, randomly stratified, from Brown, Jackson, and Monroe counties. Specify 1,200 addresses from each individual county. Do not attach names to the addresses. Matching names to addresses increases costs. Give this list to Moeller Printing for mailing purposes.
    b. Alternatively, we have provided a randomly stratified sample of addresses for the survey area that we gathered using with GIS. To begin, we uploaded the address data was uploaded to ArcGIS software from the Indiana Geographic Information Office (IGIO), which maintains a 2017 geospatial data layer of statewide addresses. We then isolated records from this dataset for Brown, Jackson, and Monroe counties and extracted only residential addresses. We then processed the new geospatial file to randomly stratify the sample proportional to address density. The sample includes 1,200 addresses from each county. Please see Appendix N for details on the sources and methods we used to create this sample. We are providing this product as Microsoft Excel and Word files (Appendix O). The Excel file includes the raw address data for the sample, while the Word file has been formatted into printable labels.

2. Pilot studies (optional)
    a. Pilot studies are an optional, but useful tool to test survey design and WTP ranges assigned within the surveys. Implement the CV survey as laid out in this guide, but with a smaller sample size. Use the pilot study to ensure that the survey design is functioning as desired. The results can inform qualitative changes to the survey that may impact how respondents understand the questions and to allow for revisions to the WTP step size and values used in the primary survey protocol. By assessing the average WTP, the implementing team can tailor the WTP range to the local community (*e.g.*, narrow the range, shrink the step size, and shift the center value of the range as needed). Pilot studies can also reveal that the sample size in the primary study will need to change.
    b. For example, if respondents consistently seem to say that they would always pay some of the lower dollar amounts, like $2 each year as shown in Table 10, it may be best to eliminate some of these low values from the analysis. To do this, FoLM would remove that category, so that they would have 6 different dollar categories instead of 7. With this reduced number of categories, 600 copies of each would need to be printed to ensure that a total of 3,600 surveys was still printed across the three counties. Similarly, if no respondents choose the highest dollar amounts, the researchers could shrink the WTP range towards the smaller value end of the range.
3. Survey production (printing, etc.)
    a. If pilot studies are not pursued, FoLM will need to print seven different versions of the survey. The surveys will differ in the monetary value asked in the contingent valuation section. For each set of assigned monetary values, 516 copies of the survey will need to be printed and distributed evenly across each county, with 172 copies of each survey type randomly sent within a given county. Table 10 shows how survey questions 10 and 13 will need to be modified in each survey.
    b. Contact Moeller Printing at 317-353-2224. This firm is capable of handling printing and mailing in house. Send the files needed for printing and mailing and specify quantities for each survey version (listed in table). Request printed surveys (black and white, double-sided) mailed and stuffed with #9 reply envelopes. Additionally, request 3,612 printed follow-up postcards to the same addresses. These will be used to remind the receivers to fill out the survey. Make sure that Moeller Printing knows that 172 copies of each of the survey variations below must be sent to the different counties. Collected data will not be valid unless all counties receive 172 copies of each survey variation (this number assumes no pilot studies).

Table 10: Number of copies for each question value.

	Question 10		Question 13	
Copies required	**$X**	**$Y**	**$X**	**$Y**
516	$2	$10	$2	$10
516	$10	$50	$10	$50
516	$18	$90	$18	$90
516	$26	$130	$26	$130
516	$34	$170	$34	$170
516	$42	$210	$42	$210
516	$50	$250	$50	$250
Total = 3,612				

4. Survey distribution (mailing, repeated mailers if necessary)
    a. Provide the mailing address list from Marketing Systems Group to Moeller Printing for survey distribution. FoLM will need to provide a return address for the #9 reply envelopes. This return address is where the completed surveys will be sent.
    b. Request for follow-up postcards to be sent two weeks after the original survey. Follow-up post cards are the same for all addresses. Postcards and surveys will both be sent to the entire list.
    c. Respondents will be responsible for postage unless FoLM applies for business reply envelopes (see Appendix K).
5. Data retrieval and storage
    a. The responses will be sent to the reply address on the #9 envelope included in original survey distribution.
    b. When paper surveys are returned or collected, look at the first survey question and sort responses by county.
    c. Following the instructions outlined in Appendix F, input the results from each survey in the specific Excel document for each respective county (Appendices G, H, I). Do not alter this Excel document other than raw data entry, as cells are carefully internally referenced. Inserting a column incorrectly might interfere with data analysis. An example Excel document is included (Appendix J) to show correct data formatting and the analyzing capabilities of the spreadsheet.
    d. This data will need to be encrypted as it contains personal information. Services like Box ensure encryption.
6. Travel cost analysis
    a. If data is input correctly, following the above procedure, travel cost analysis results for each individual county will be found in cells G12 and G13 on the "County Results" page of the Excel file for each county. These results can be interpreted as a low-end and high-end estimation of how residents currently value Lake Monroe across the analyzed counties.
    b. The results for each county can be summed together to arrive at an estimation of total value across the three counties.
7. Contingent valuation analysis (SAS code)
    a. To analyze the data in the style of a single binary discrete choice, follow the instructions laid out in Appendix M.

b. To analyze the data from the double binary discrete choice, we recommend seeking out a professional data analyst in the O'Neill School or a consulting firm.

8. Interpreting the data (limitations)
    a. While the data from the CV study can be useful to gauge the public's support for a budget for developing a water fund for Lake Monroe, FoLM should remain aware of potential sources of bias among respondents. To help mitigate this risk, CV questions were written at an 8th-grade reading level and screened through Qualtrics survey software to minimize common sources of bias caused by question wording. Despite these safeguards, unobservable factors, such as an individual's level of education or political leanings, will continue to affect each respondent's WTP. Therefore, FoLM should remain mindful of these and other sources of bias when interpreting the CV results. Respondents may also take on strategic behavior when taking the survey by over or underestimating their WTP.

5.3 Summarized Budget

Table 11: Budget dependent on different CV implementation methods.

	Print	Folded	Stuffed	Addressed	Mailed	Postcards	IU Rep	$ Postcards	$ Surveys
IU Document Services	X	X	X	X	X	X	X	$612.00	$2,304.00
White Rabbit	X							N/A	$1,440.00
Moeller Printing	X	X	X	X	X	X		$781.91	$2,149.52

While there are several firms capable of providing the necessary printing and mailing services, we list the options that are most feasible with respect to implementation cost and time burden. Appendix K describes the breakdown of costs and researched options in detail, and Table 11 provides a brief overview of services and prices. We used a sample size of 3,600 (1,200 per county) and survey length of five pages for budget calculations. The recommended budget is approximately $3,656.96.

Moeller Printing is a firm in Indianapolis, Indiana that provides printing and mailing services. The entire cost of printing and mailing surveys along with follow-up postcards will cost $2,873.95. This price estimate includes printing, stuffing, addressing, and mailing all items. Postage is not included.

Marketing Systems Group is a private firm that provides research assistance. This firm works with the United States Postal Service for their address-based sampling projects. For this project, Marketing Systems Group's total fee is $687.00. This covers the start-up costs and 1,200 samples per county.

To fund this project, there are a few options. FoLM could continue to partner with Indiana University students, Capstone projects, or hire a summer intern. Otherwise, there are several grants for environmental non-profits. We list the details (names, due dates, monetary amounts) for these options in Appendix K.

6. Conclusion

Lake Monroe provides multiple benefits to surrounding communities. Water quality is important to ensure safe drinking water for residents of Bloomington, Ellettsville, and Nashville, Indiana. As water quality decreases, the costs involved with chemical treatment will increase. In periods of high organic content within Lake Monroe estimated chemical costs can increase almost three-fold. Water clarity can also have impacts on property values. Based on our research, increased turbidity can lead to a decrease in property value. Preserving water quality in Lake Monroe could save the city money and help preserve the property value around the lake. The improvement of lake water is comprehensive in nature, incorporating a variety of aspects, such as wetland restoration, land use management, wastewater inflow treatment, invasive species control, and water quality monitoring.

Additionally, Lake Monroe provides numerous benefits in terms of business and recreation. The lake attracts visitors from all over the region who funnel money into the area, which creates jobs, tax revenue, and many other benefits for Bloomington and the surrounding area. Based on our survey over half of local businesses are affected by lake-related traffic. Lake Monroe inherently provides the region many economic benefits that are enjoyed by a multitude of stakeholders.

Ecosystem services provided by lakes are numerous and are rarely put a price on, but directly benefit humans and human-built structures. Placing a monetary value on an ecosystem service would allow watershed communities to understand that they benefit from a lake in more ways that they could think of. The ecosystem services literature review reflects monetary values that do not directly come from Lake Monroe's economic evaluation but could be used as an estimate of the ecosystem services value that Lake Monroe provides.

Similarly, the contingent valuation study will provide further insight to the intangible benefits of the lake. While the contingent valuation study is expensive and time consuming, the outcome will be county specific, statistically significant, and directly applicable to Lake Monroe. These results will help value recreational benefits to residents of Monroe, Jackson, and Brown Counties. This allows FoLM to understand how residents in the watershed truly value the lake.

The six methods used in this study have serious limitations, outlined in Table 12. The water treatment cost assessment, property value assessment, stakeholder reports, and stakeholder survey all suffered from serious data constraints. While water treatment cost assessment, stakeholder reports, and stakeholder survey values are specific to Lake Monroe, none of these methods are specific to county, as requested by FoLM. While all methods except for the contingent valuation study are immediately implementable at zero cost, none are statistically significant, reducing our confidence in the findings. The contingent valuation study will provide values for Lake Monroe specific to counties that are both robust and statistically significant, but will require time, workhours, and money to implement.

Figure 12: Illustration of the strengths (marked with an X) of the six methods used in this report.

	Method Strengths					
Methods	Lake Monroe Specific	County Specific	Immediately Implementable	Zero Cost to Use	Robust	Statistically Significant
Water treatment costs	X		X	X	X	
Property values			X	X		
Stakeholder reports	X		X	X	X	
Stakeholder survey	X		X	X		
Case study analysis			X	X		
Contingent valuation	X	X			X	X

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Appendix A: Stakeholder Map

To create this map, the Public Land Survey System (PLSS) county layer, the Lakes, Ponds, Reservoir, Swamps, and Marshes layer, the Land Parcels shapefile, and the Real Property Assessment Data spreadsheets from IndianaMap were downloaded. Then, the PLSS counties layer was used to check that the other layers were positioned correctly, then Monroe, Brown, Jackson, and Lawrence counties were selected and exported into their own layer. The Real Property Assessment Data spreadsheet was then joined to the Land Parcels shapefile, and all layers and shapefiles were clipped using the exported counties. Lake Monroe was selected from the Lakes, Ponds, Reservoir, Swamps, and Marshes layer, and a 30-mile buffer was created around it using the buffer tool. A select by location was used to select those parcels in the layer, and then the selected parcels were exported into their own layer. The exported parcels were then selected by attribute, using the following SQL statement to select those properties that held businesses, as seen in Figure 1.

Figure 1: SQL code used to select GIS parcels.

```
Parcel.PROPERTY_CLASS_CODE = '310' OR Parcel.PROPERTY_CLASS_CODE = '370' OR Parcel.PROPERTY_CLASS_CODE = '410' OR Parcel.PROPERTY_CLASS_CODE = '411' OR
Parcel.PROPERTY_CLASS_CODE = '420' OR Parcel.PROPERTY_CLASS_CODE = '421' OR Parcel.PROPERTY_CLASS_CODE = '422' OR Parcel.PROPERTY_CLASS_CODE = '425' OR
Parcel.PROPERTY_CLASS_CODE = '426' OR Parcel.PROPERTY_CLASS_CODE = '427' OR Parcel.PROPERTY_CLASS_CODE = '428' OR Parcel.PROPERTY_CLASS_CODE = '429' OR
Parcel.PROPERTY_CLASS_CODE = '430' OR Parcel.PROPERTY_CLASS_CODE = '431' OR Parcel.PROPERTY_CLASS_CODE = '435' OR Parcel.PROPERTY_CLASS_CODE = '439' OR
Parcel.PROPERTY_CLASS_CODE = '440' OR Parcel.PROPERTY_CLASS_CODE = '442' OR Parcel.PROPERTY_CLASS_CODE = '450' OR Parcel.PROPERTY_CLASS_CODE = '451' OR
Parcel.PROPERTY_CLASS_CODE = '452' OR Parcel.PROPERTY_CLASS_CODE = '453' OR Parcel.PROPERTY_CLASS_CODE = '455' OR Parcel.PROPERTY_CLASS_CODE = '456' OR
Parcel.PROPERTY_CLASS_CODE = '462' OR Parcel.PROPERTY_CLASS_CODE = '463' OR Parcel.PROPERTY_CLASS_CODE = '464' OR Parcel.PROPERTY_CLASS_CODE = '465' OR
Parcel.PROPERTY_CLASS_CODE = '490'
```

The selected parcels were exported into their own layer. A basemap from ESRI was selected to give some locational information and put under the latest layer. The information from this layer was copied into Excel.

As survey results came in, each respondent was searched on Google Earth. The resulting map was exported into a KML format. The resulting table was put into a program called Google Fusion Tables, and exported into a .csv document, which was opened in Excel where the x and y coordinates were separated into their own columns. This Excel document was saved as another .csv document, and imported into ArcGIS. A tool called add xy coordinates to create a shapefile of the locations. To create the map, a basemap was chosen from the add basemap option, and the exported parcel and location layers were added on top. Figure 2 shows all the respondents of the survey, while Figure 3 shows a zoomed in view to be able to compare the survey respondents to the selected parcels. Figure 4 shows all the respondents above along with a visualization of the 30-mile buffer.

Figure 2: Map of all survey respondents. Source: Capstone 2019.

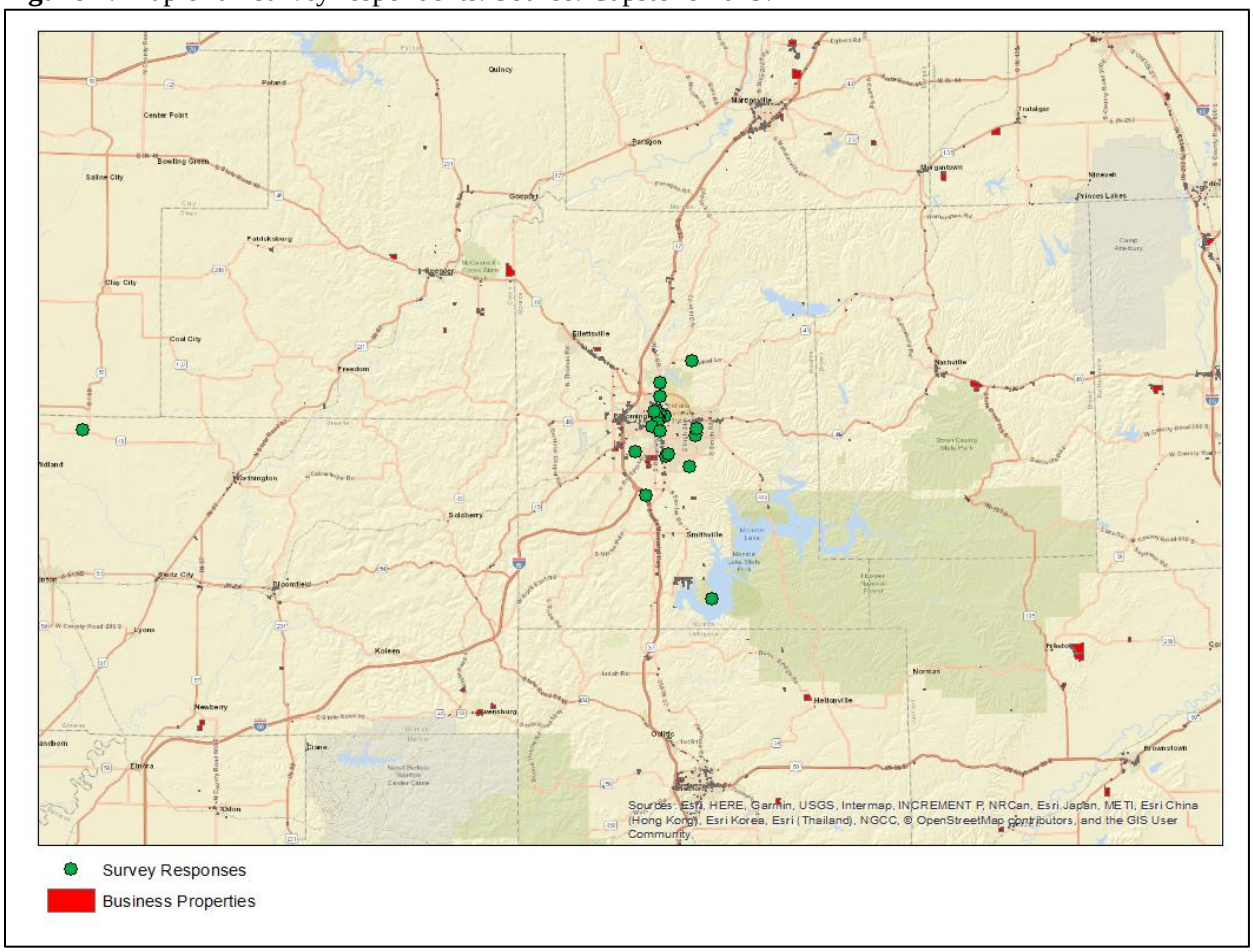


Figure 3: Closer view of Bloomington survey respondents map. Source: Capstone 2019.

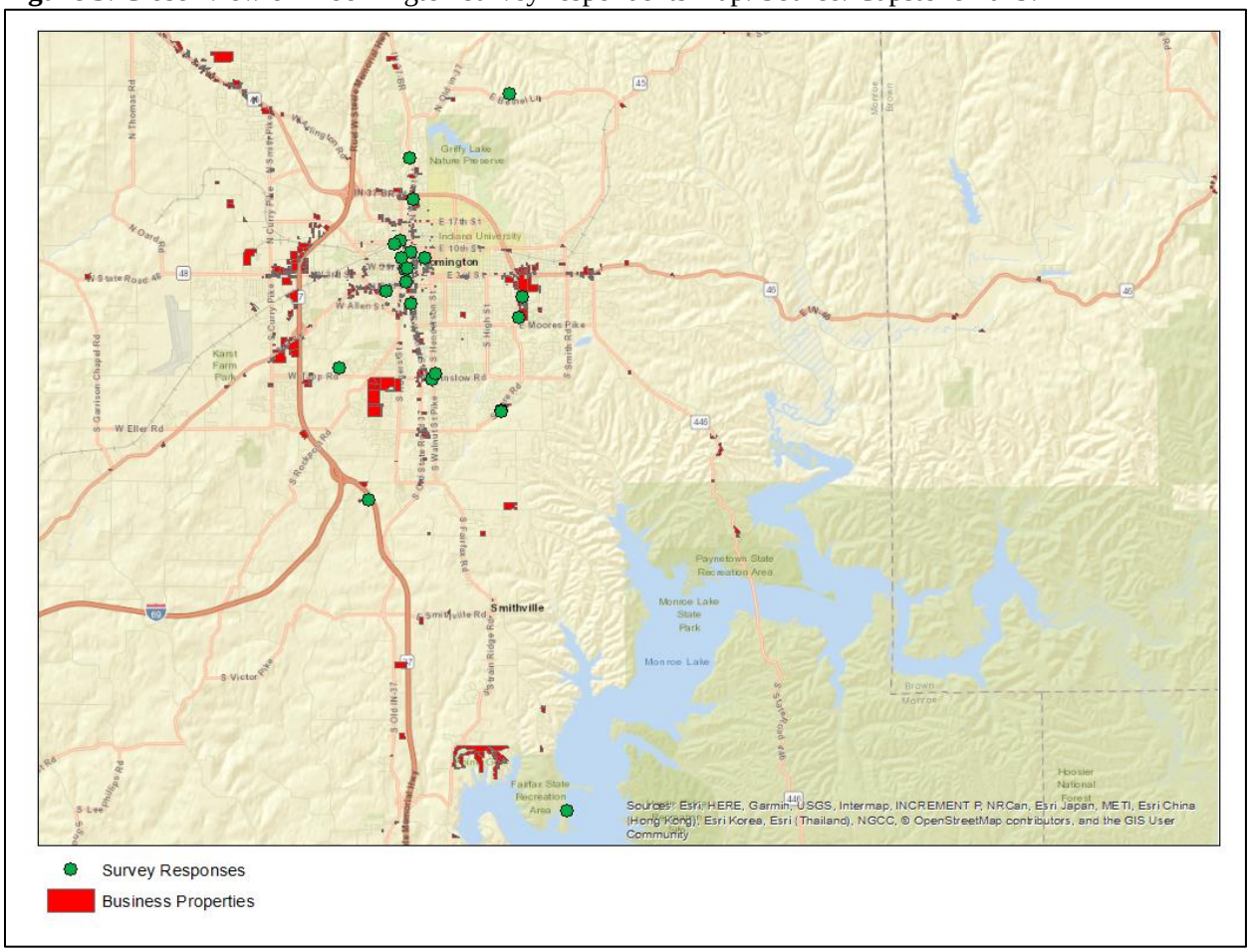
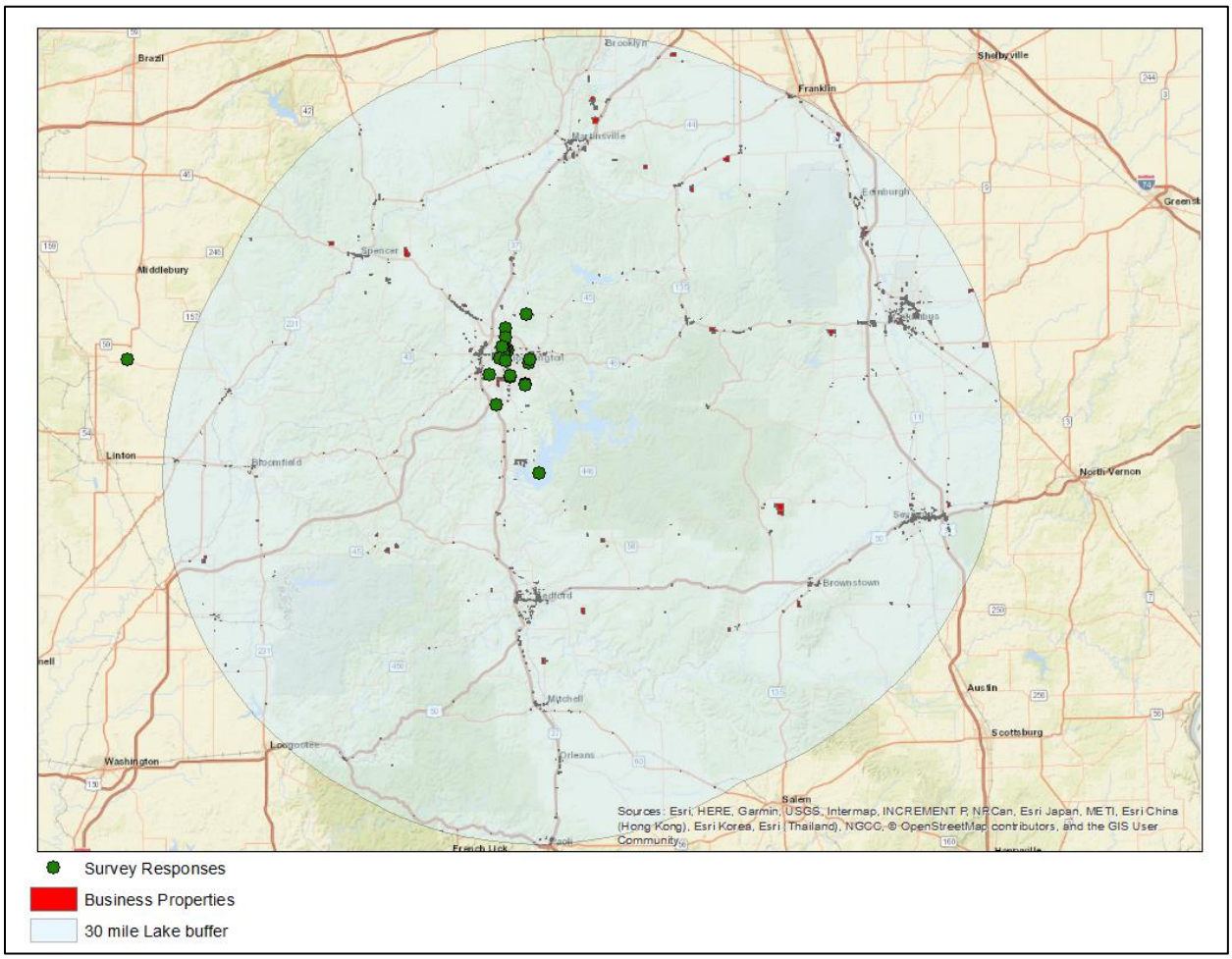


Figure 4: Map of survey respondents with 30-mile buffer. Source: Capstone 2019.



Appendix B: Visit Bloomington 2018 Visitor Profile Study

Share of **leisure visitors** who participated in activities/attractions *Average # of activities per trip: 4.3*			
Dining at a locally owned restaurant	49%	Museums	10%
Shopping	49%	Performing Arts	8%
Scenic drives	30%	Attending a concert	8%
Sightseeing	29%	Swimming	7%
Dining at a chain restaurant	23%	Art gallery	7%
Visiting a park	23%	Camping	6%
Outdoor activities	20%	Visited a sports venue	6%
Nightlife and entertainment	18%	Boating and watersports	5%
Activities on IU campus	18%	Fishing	4%
Wineries/Breweries	17%	Comedy	4%
Arts and cultural activities	14%	Bird watching	4%
Festivals/events	14%	Running	4%
Historical sites	13%	Golf	3%
Farmers' market	13%	Cycling/mountain biking	2%
Cinema	12%	Snowmobiling	1%
Hiking	12%		

Share of **sports visitors** who participated in activities/attractions *Average # of activities per trip: 3.9*			
Visited a sports venue	54%	Golf	6%
Dining at a locally owned restaurant	51%	Attending a concert	6%
Activities on IU campus	50%	Museums	5%
Shopping	42%	Performing Arts	5%
Dining at a chain restaurant	23%	Art gallery	5%
Nightlife and entertainment	20%	Cinema	4%
Wineries/Breweries	16%	Historical sites	3%
Outdoor activities	15%	Running	2%
Scenic drives	14%	Cycling/mountain biking	1%
Sightseeing	14%	Camping	1%
Arts and cultural activities	12%	Bird watching	1%
Visiting a park	10%	Comedy	1%
Farmers' market	9%	Boating and watersports	0%
Festivals/events	9%	Fishing	0%
Swimming	7%	Snowmobiling	0%
Hiking	6%		

Share of **business visitors** who participated in activities/attractions *Average # of activities per trip: 3.3*			
Dining at a locally owned restaurant	37%	Comedy	9%
Activities on IU campus	33%	Cinema	9%
Shopping	25%	Museums	9%
Sightseeing	23%	Farmers' market	5%
Dining at a chain restaurant	19%	Fishing	5%
Nightlife and entertainment	16%	Swimming	5%
Visited a sports venue	16%	Historical sites	4%
Scenic drives	14%	Performing Arts	4%
Festivals/events	12%	Outdoor activities	4%
Arts and cultural activities	12%	Bird watching	2%
Attending a concert	11%	Golf	2%
Art gallery	11%	Boating and watersports	2%
Wineries/Breweries	11%	Hiking	2%
Visiting a park	9%	Camping	0%
Cycling/mountain biking	9%	Snowmobiling	0%
Running	9%		

Agreement that the following describes Bloomington *Mean scores on scale where 1=disagree strongly and 5=agree strongly*	Overall
Academic	4.3
Has great restaurants and food options	4.1
Has natural beauty/scenic landscape	4.1
Friendly	4.1
Accepting	4.1
Family Friendly	4
Is a great place for outdoor recreation	4
Diverse	3.9
Easy to get out	3.9
Progressive	3.9
Charming/quaint	3.9
Is easy to get around once I am there	3.9
Lots to see and do	3.9
Artsy	3.8
Relaxing	3.8
Affordable	3.7
Hip	3.7
Is a unique destination	3.7
Has unique shopping	3.6
International	3.5
Upscale	3.4
Elevated	3.3
Cosmopolitan	3.2
Expensive	3
Hectic	2.8

Appendix C: Survey Result

Business Name	Age of Business	Type of Business	Years under current management	Years under current ownership	County of business location	Is your business locally owned?	Seasonality of your business	Does Lake Monroe affect your business? If yes, how so?	Does your business benefit from Lake Monroe? If yes, how so?
Smithville Food Mart		Convenient Store	6	Option 1	Monroe		Year Round	Yes. Summer brings the lake traffic which helps the business.	Much more traffic than winter.
Grant Street Inn	28 years	Hotel/Inn	28	28	Monroe	Yes	Year Round	No, not directly	Yes, it is a draw to Monroe County and Bloomington. This brings visitors to the area.
WonderLab Museum of Science, Health, and Technology	15 years	Museum, Non-profit	2	15	Monroe	Yes	Year Round	Not really.	Not really. Maybe if families travel to visit the lake but then come into town.
Fourwinds Lakeside Inn & Marina	46 years	Hotel/Resort	7	18	Monroe	No	Summer	The lake is the attraction for visitors and guest.	Yes, it is the reason people want to visit, and stay here.
Sharp Designs & Illustration Inc.	12 years	Art Studio	12	12	Monroe	Yes	Year Round	Yes. Our studio has seasonal views of the lake, and its location is ideal for clients and patrons to visit the studio, view artwork, and consult with us on book projects, and other commissioned works. Our location provides a quiet work environment for two full-time artists.	Same as above.
Visit Bloomington	42 years	Marketing	42	42	Monroe	Yes	Year Round	Yes. We promote the area's tourism industry. Monroe Lake is one of our most popular attractions.	Yes. Monroe Lake business positively impacts the area economy and that benefits all local businesses.
Visit Bloomington	30+	Tourism/Hospitality	11	N/A	Monroe	Yes	Year Round	Yes, the lake is a huge source of tourism for our area.	Yes, it brings in thousands of visitors (& locals) who enjoy the lake and surrounding forests for hiking and camping
Harris Services	15 yrs	Residential/Commercial Clean-Repair-Reatore	15	15	Monroe	Yes	Year Round	No	Homes around the lake
German American Bank	109	Bank	2	2	Monroe	No	Year Round	No	No
Bailey & Weiler Design/Build	14 years	Home builder	14	14	Monroe	Yes	Year Round	Indirectly	Attractive secondary home location
One World Catering	10 years	Catering	10	10	IN	Yes	Year Round	no	no
Comcast	55 years	telecommunications/development	9	9	monroe	Maybe	Year Round	we have customers whose income is derived from the lake	we have customers whose income is derived from the lake
LIFEDesigns Inc	30+ years	Human Services	2	7	Monroe	Yes	Year Round	No	No
Hampton Inn	32 years	Hotel	32	15	Monroe	No	Year Round	Destination for tourist	Hotel to house guests who are using the lake for vacation
Hyatt Place	4	Hotel	4	4	Monroe	No	Year Round	Yes, visitors who are visiting for events at Lake Monroe some times stay with us	Yes, see the answer to the previous question
Orion Real Estate and Property Management	10 years	Real estate sales and property management	10	10	Monroe	Yes	Year Round	I don't think that much.	No
Office Easel Promotions	30 years	Promotional product sales	30	2	Monroe	Yes	Year Round	No	Some of my clients may use in their marketing
World Ventures - Bloomington	4 years	Travel	4	4	Monroe	Yes	Year Round	Yes, the lake is able to bring more members and prospects through Monroe County.	Yes. It brings more members and prospects to Monroe county that are typically outside. I can connect with them during the summer and set appointments, then they like to take vacations during the other seasons. I have also met with the Indiana Small Biz Development office about starting a couple businesses on the lake.
Rubicon	16	Construction-Development-Management-Realty	16	16	Indiana	Yes	Year Round	Yes, it makes everyone happy!	Provides amenity to buyers and investors. good source of drinking water.
The Tailored Fit	18	Alterations, Tailoring, Sewing classes, Fabric store	18	18	Monroe	Yes	Year Round	No	No
Class 101	8 years in Bloomington, 22 years Nationally	College Planning	8	8	Monroe	Yes	Year Round	No	No
JPF Properties	10 years	Real Estate	10	10	monroe	Yes	Year Round	no	it could
RE/MAX Acclaimed Properties	10+ years	Real Estate Sales	10	10	Monroe	Yes	Year Round	Yes! Boaters and other lake enthusiasts buy condos, houses, and rental property for themselves and their friends and family to enjoy during the warmer months.	Yes. See above.
Aging Options and Advocacy	Aging Options and Advocacy	Aging Options and Advocacy	1	1	IN	Yes	Year Round	Slightly due to the draw of seniors and homecoming	Draw of clients
	30 yrs	real estate brokerage	28	28	Monroe	Yes	Year Round	yes - can impact residential sales. Community amenity and water quality	May further further nearby development
StickersAndMore.Com / IFL	StickersAndMore.Com / IFL	StickersAndMore.Com / IFL	19	19	daviess	Yes	Year Round	campers	campers
Senior Helpers	Senior Helpers	Home Care for Senior		1 Year	Monroe	No	Year Round	No	No
Scenic View Restaurant	30	Resort Restaurant Lodging	10	10	Monroe	Yes	Year Round, but limited hours off season	Plenty of tourists and locals vacationing and recreating in the area, our space is a perfect to and / or from stop to the Lake	Yes, added business in the on season / summer Lake traffic
LIFEDesigns, Inc.	Founded in 1982	Non profit	1.5	37	Monroe	Yes	Year Round	Not directly ???, but possibly indirectly. We use city water in our office, and much of our work is done in peoples' homes, which they all would use water as well.	Not directly.
% Response	23/27 (85%)	27/27 (100%)	26/27 (96%)	26/27 (96%)	27/27 (100%)	26/27 (96%)	27/27 (100%)	27/27 (100%)	27/27 (100%)

What is the importance of Lake Monroe to your customers/clients?	Does your business offer recreational activities/events involving Lake Monroe? Please describe	How would you describe your customer/client base? (Locals, visitors, recreaters)	Are there any activities/events/services that you you wish Lake Monroe provided, that aren't provided already? If yes, please describe
Our customers go fishing, swimming, boating, etc.	No	During some local to visitor/recreators is lower. During winter local to visitors/recreators is higher.	
Adds to the overall draw of the region.	No	Visitors. IU Alumni, parents and academics visiting IU.	No
Not very important	No	Locals, visitors, families	NA
With the largest marina on the lake, this is a major component for the individuals who dock their boats here, and use the lake	Boat Rentals, Boat Shows, Private Beach	Local, couples, and families who live within 90 minutes of the lake.	Floating Hot Dog Stand
It's a great destination for our clients to visit. The Moores Creek boat ramp area and Sailing Marina provide shelter houses for gatherings of artists and clients. The Bloomington Watercolor Society's plein air group has also painted outdoors at these sites.	no	In-state customers	Hosting a paint out similar to the TC Steele Historic Site events.
One of our most popular attractions.	Yes we promote all kinds of lake activities.	Visitors	National ice fishing tournament in the winter.
The natural setting. It's the largest lake in the state and there are lots of activities, and things to do as a family.	We don't offer them but we heavily promote those businesses that do, including the IN DNR and their activites, and just the lake and forest itself.	Locals and visitors alike	Guided boat/hiking tours for bigger groups visiting the area
Leisure	No	Locals	Town home colonies for weekend vacationers to enjoy golf/beach/lake by building across from the Pointe.
Some have houses and boat a lot on the lake	No	locals	No
Key when looking for a secondary home.	No	Local and out of town buyers	More restaurant options with access from lake
none	no	locals	no
recreation/vacation/water	no	locals	cleaner water quality
Our clients enjoy going to the lake for outings	Our clients like going to the lake for picnics and such in the parks.	Locals	
Destination for tourist	Not directly	50% Local Business, 25% Tourists, 25% University Driven	
Options for activities while visiting are important	We recommend Lake Monroe for guests looking for recreational activities	Visitors	Potentially a shuttle service to and from the State Park area
Very little. I have had few clients that buy because they want to live on or close to Lake Monroe.	No	Locals or IU related	No
Currently not high	no	locals	no
It is a central location for fun-loving people.	I plan a boat party for active members 1-2 times per year. Beyond that, I would like to provide recreational services on the lake such as small motorized craft rentals, but have been discouraged through talks of businesses being discouraged or illegal from taking place on the lake, which is why I'm meeting with the Small Biz Dev office of Indiana.	Locals, Visitors, all fun-loving people that enjoy travelling	Yes, but I don't care to share those as I am interested in starting a business to run them if allowed.
Very important for recreational use.	yes	all	none
they love the lake	no	60 and under, very few visitors	a decent restaurant
We enjoy taking clients out on our boat/jet skis	No	mainly local, however we train new owners from all over the world	More areas and ease of access for bath rooms, I hear other locals talk about peeing in the lake all the time. It makes me nauseous.
some would like to have places nearby for access	no	local	more owner occupied properties with dock frontage
The lake provides terrific views for those fortunate enough to buy a home with a view and provides all that are interested in the opportunity to fish, ski, swim, float, relax, and boat in our beautiful lake.	No.	My client base is all over the board. Locals, part-time residents, people relocating for work or to retire here.	A Zoom Floom like we had when we were younger would be a huge attraction. I would love to see another one put in. A Splash Pad for younger kids would also add to the family fun.
Fair	Lake trips and fishing camping	Seniors and visitors	More senior activities for day
Water quality and leisure activities	no	locals and visitors	no
Retreats	no	Retreats	No
not sure there is a connection	No	Locals	No
Recreation / relaxing / resort environment / outdoor serenity	Live music / themed foods around Resort holidays / Lake traffic / nearby hiking trails and boating	area locals / downtown * IU students and families for events / recreational visitors	
Believe mostly a space for recreation, a source of water for home use.	No.	people with intellectual and developmental disabilities	Not sure.
27/27 (100%)	27/27 (100%)	27/27 (100%)	25/27 (92%)

Does your business offer any benefits to: The community? The visitors? The State? The County?	What can you say about the condition of Lake Monroe?	How could Lake Monroe be improved generally?	What are your business' peak months: Of visitation? Of revenue?	What is your business' procurement process?
			Summer months	
Yes, we are a 40 room boutique Inn offering accommodations for all.	Good	Facilities updated	Spring and Fall	
Yes. We are the only science museum with family activist operating year round in Monroe County.	NA		October - August	
Our business is a destination, which brings dollars to the community, state, and county	Good condition. More people should b e considerate, and not litter, especially along the shoreline.	Add another restaurant for dock, and dine option.	May through September	N/A
Art studio. Every community needs local artists.	I am very concerned about the degradation of water quality, 18 wheel logging trucks driving past on our narrow road, and erosion due to current logging activity on steep slopes on lakefront property on our road (Shady Side Drive).	Logging restrictions, and more public access to boat waste disposal areas and recycling bins.	visitation peaks in Spring and Fall	online
Yes we provide tourism services to visitors and partners.	Happy it is is protected.	More clean-up and protection.	March-October.	Economic impact.
We offer a wealth of resources with our visitor guide, ads, and website to promote all the Bloomington and Monroe County have to offer	I think it's pretty good, it always looks very well-kept and clean. I'm sure we can all do a better job of policing our trash and carbon footprint when we're there though	Keeping the land and trees that we have. I'm glad it isn't a vacation/housing community like many other lakes in our state.	Spring/Summer/Fall	N/A
One call can do it all with any service needed for home or office	Not aware	Offer activities similar to the Madison regatta	Year round	NA
yes, donate lot to organizations and community causes, and lending, insurance, investment, banking services to individuals and business'	I love the lake, but do think that it gets very dirty.	cleanliness	not sure, year round	not sure
Employment, support local charities	Good water quality but must continue to be monitored and managed.	Improved access to southern edge.	Year round	Local suppliers and online.
yes, many. We underwrite events for not for profits	wouldn't swim in it for sure.	remove power boats	May, October	n/a
yes	OK, but not the cleanest lake	cleaner water,	12 months a year	analysis, request, obtain, purchase
			April through November	Online Reservations
We provide quality accommodations with Hoosier hospitality and generate tax revenues as result	I think it is in good shape, perhaps under developed, but as a state park that is to be expected	accessibility, 20 minutes from downtown Bloomington with a park entry fee. That's about it.	April, May, Sept, Oct for both questions	We utilize a 3rd party procurement company
No	Its dirty	Clean up of shore lines and build more lake related activities.	All except Jan and Feb.	Advertisement
We help business's market themselves	Nice lake	no sure	August, September and October	We work with people we know
Local community and visitors alike can earn points towards vacations through our DreamTrips local partnerships. Previously active at Yogis before closing.	Beach areas are not very well maintained compared to northern Indiana.	More maintenance and DNR should be looking for more people abusing the lake and doing stupid stuff rather than pulling over boats where they suspect drivers are drinking.	Spring-Fall for revenue. Visitation: N/A, currently a home-based business	Company Credit Card
yes, to all	shallow, runoff from Brown County causes silt buildup	Encourage surrounding counties to maintain shore lines and contributing water ways.	year round	
The community we help you look wonderful	it's fine	Better places to eat /shop	Sep- Dec, March - May	selected vendors
We provide free assistance to at risk youth to help ensure they do all of the necessary paperwork.	Bathrooms mentioned above and trash. Is it possible to provide areas perhaps were boaters fill up or at camp grounds for people to dispose of trash? Maybe they would not dump as much in the lake.	Fewer homes lake front	March, June, September, December	word of mouth
we are commercial real estate developers that build all types of product - Lake Monroe would offers some nice areas for some further development	good	economic infrastructure and incentives for development	does not apply	we use local channels
We guide buyers and sellers in the process of buying and selling their home or summer get away.	I'm not qualified to answer this question. I believe there is a lot of "trash" that is/has been dumped in the lake. That's always disappointing.		Spring and Summer	
Senior care options and Advocacy	Not pleased with the condition at Crooked creek. Unable to launch a fishing boat.	Be a bit more lenient with campers on the surrounding sites	Jan thru June	
no	excellent		spring/summer	na
No	Good	N/a	StickersAndMore.Com / IFL	purchase orders
no	very good condition enjoy it as a family recreation area	unsure	all year	unsure
Resort and recreate in a family environment / local business support / donations to local events / proceeds	Simple	Bike bath from 3rd Street down 446 to Lake Monroe could be a nice attraction / connecting with hiking trails / stops along the way / food / beverage / water recreation	depending upon weather March -October on season Nov-February off season . Peak months: Summer June / July / August then again with leaf viewing October	food and beverage
Yes. Our business helps people with disabilities find employment, and we provide staff to support and care for people with developmental/intellectual disabilities so that their family members can work instead of providing care. Our organization really helps economic development for the whole community, and helps people with disabilities contribute to their community as consumers, as volunteers, as employees, and more.	I honestly don't know that much about it.	I think the only thing I know about is really cleaning the water for public use and wildlife protection.	Not applicable.	
24/27 (88%)	23/27 (85%)	20/27 (74%)	26/27%)	N/A

Does your business' proximity to the lake affect your operations?	What is your water supply source? Quantity of water use? Is any further treatment required?	How do you characterize the annual revenue and profit trends of your business from beginning to present?	Our group is searching for information related to businesses which benefit from Lake Monroe. Would you be willing to provide us with information about your business' finances following up with this survey? (i.e. Profit/loss reports, monthly and/or annuall	If no, would you be willing to indicate if sales increased or decreased for any years between 2006 to 2016 by percentage (i.e. sales decreased 2% from 2006-2007)?
			No	
No	Bloomington city water	From opening through about 2014 always rising. 2015 to present, on the downswing.	No	
No	City Water	Steady	No	
No	Unable to answer. Water supply not an issue.	Season not an issue, over building of downtown hotels does effect the potential of off-season business, as it is more difficult to attract guest during fall/winter. Occupancy has increased by 4-8% annually, and for the past 6 years, Average Daily Rate (ADR) has increased bymore than 25%. Management has used creative marketing in the past 7 years to remain competitive, versus marketing attempts prior to 2012. At one point the resort/inn would close for winter months. This has been a non-issue since 2013.	No	
Tranquil setting = creativity	Shady Side Water Corporation, which sources from Bloomington Utilities Water Plant on Shields Ridge Rd.	Annual revenue has been consistent since 2008. It was greater before '08.	No	Yes
No.	NA.	Growing.	No	Increased 60%.
No. We're not just promoting the lake	N/A	N/A	Maybe	
no	No	NA	No	Increased.
no	not sure	not sure	No	I'm not the right person to ask, sorry.
Must be within reasonable driving distance for projects on the lake.	City water. No further treatment needed.	Increasing	No	Started in 2005, so the percentage growth from 2006 would be enormous. Average annual growth 10-20%
no	City of Bloomington. Yes, we use purifiers for cooking and drinking	increasing dramatically	Yes	
it does not	no, but quality of water in lake is dirty	growth	No	yes
No			No	No
	City Water		No	Yes
no	City of Bloomington Water. I am not sure of the quantity of use	consistent with slight growth	No	This property opened in 2014. Sales have increased by about 2% each year
No	NA		Maybe	Increased every year.
no	no	Slowly growing	No	increase 1%
No	N/A	Primary revenue started in Monroe County when launched in 2015, then started coming more from outside Monroe County 2016-2018, but now growing within the county again since mid-2018	No	Sales decreased 20% from 2016-2018, but have increased in 2019
no	Monroe		No	
no	City of Bloomington Utilities, drinking & restrooms, no	my annual revenue has double in the last several years, my business slowly has grown until 2 years ago and then it's grown dramatically.	No	Since my business doesn't really relate to the study I'm guessing I won't be helpful
No	City water, I don't know, Not that I am aware of	Always increasing	No	Always increasing, however I do not feel that Lake Monroe is the reason.
no	city	does not apply	No	does not apply
No.			No	My sales have increased every year since 2006 but I do not know by what percentage from year to year.
			No	Yes
no	CBU/minimal/no	stable	No	yes
no	County	Fair	No	
no	city water		No	need to get to the office
Yes, its meant to be on the way and a beautiful view	East Monroe water company / quality is fine /except when 4 times a year there's some sort of water main break that affects our business in quality and speed	we are outdoor heavy restaurant, our business is directly affected by weather	Maybe	maybe
Not particularly.	City water is our supply source, I'm not sure on the quantity, but I would guess a lot. We have a kitchen in our office, and 4 bathrooms. We filter water before drinking it, but otherwise no additional filtration is needed to my knowledge.	Our organization has been able to increase revenue overall from beginning to present, but the largest source of revenue is Medicaid, and that has shrunk dramatically a few times over the years. It has been increased a little bit in recent years, but not enough. Additionally, we've found other ways to increase our revenue through our Employment program, and through fundraising and other partnerships.	No	You can see our 990 and other basic financial information on Guide Star. You probably one see what you're looking for in terms of sales during the timeframe 2006-2007. I can tell you that the crash in 2008 was when we lost substantial funding from Medicaid which resulted in reduced quality of care our clients received, loss of some employees and effectiveness of our administration, and pay cuts for all employees. It's not exactly sales though...the government just decides how much they will reimburse for services and they really don't have any true basis of coming up with those costs...often times it's the place they cut when budget cuts need to be made.
24/27 (88%)	20/27 (74%)	17/27 (62%)	27/27 (100%)	19/27 (70%)

Appendix D: Ecosystem Services Metadata

Attached as an Excel file.

Appendix E: Contingent Valuation Survey

Attached as a Word document.

Appendix F: Contingent Valuation Survey Data Entry Instructions

Attached as a Word document.

Appendix G: Contingent Valuation Data Analysis – Monroe County

Attached as an Excel file.

Appendix H: Contingent Valuation Data Analysis – Brown County

Attached as an Excel file.

Appendix I: Contingent Valuation Data Analysis – Jackson County

Attached as an Excel file.

Appendix J: Contingent Valuation Data Analysis – Example

Attached as an Excel file.

Appendix K: Contingent Valuation Technical Appendix

Table of Contents

1. Survey Structure

1.1 Stated Preference Methods

While different methods exist by which individual valuation of a good can be measured, most methods can be categorized as either "stated preference" or "revealed preference." Stated preference valuation involves explicitly asking an individual about their willingness-to-pay (WTP) for the good of interest or willingness-to-accept (WTA) payment for the loss of the good. Both contingent valuation studies and choice experiments present ways to achieve this goal and obtain a valuation estimate.

1.1.1 *Contingent Valuation*

While all contingent valuation studies are classified as stated preference methods that explicitly ask an individual about their WTP, there are different ways in which questions can be framed to reach conclusions. Open-ended elicitation, discrete choice, and iterative bidding are some of the most common means by which these studies obtain data for analysis. All of these methods ask individuals to predict what they would pay in a hypothetical situation, in order to better plan for the future, when those funds might actually be required of the respondent. For this reason, these surveys can serve as a tool for forward-looking decision-making.

While contingent valuation studies serve as a powerful tool, there exist unavoidable flaws in its design and implementation. First, survey respondents are not always able to understand the hypothetical situation presented to them. Thinking about abstract financial decision-making is difficult if not properly anchored in something that feels real and credible to respondents. When asked about WTP, there is sometimes an incentive for respondents to lie in order to inflate or deflate values. These "protest votes" can be unavoidable, particularly when the study involves a controversial topic. Additionally, individuals sometimes have no true sense of their WTP, and resort to guessing.

1.1.1.1 *Open-Ended Elicitation*

Open-ended elicitation methods involve simply asking respondents what they are willing to pay for a good, without presenting them a value on which to base their decision. Individuals generate cost estimates on their own, and these estimations are analyzed. This method is viewed favorably because it necessitates a smaller sample size than discrete choice methods and allows for targeted individual responses.

While straightforward, this method is often considered flawed, because individuals tend to overestimate or underestimate their true WTP. There is little structure in place to prevent "protest votes" or decisions made purely from lack of understanding. For these reasons, we are not recommending this survey question style.

1.1.1.2 *Binary Discrete Choice*

Binary discrete choice methods involve presenting respondents with a cost value and asking them to respond with a "yes" or "no" decision regarding their WTP. The survey authors choose a range of values that they think best represent population preferences, and each survey respondent

receives a random value that they must decide upon. Binary discrete choice is most appropriate for mailed surveys because respondents generally provide more accurate answers than if they are asked open-ended questions. The structure of these questions helps to protect against "protest votes" that aim to falsely inflate output, because everyone's response receives the same weight.

One constraint of this method is that only one value is given to each respondent. This limits the amount of data received back and requires higher survey quantity in order to produce statistically valid and useful results. In order to minimize costs, we do not recommend this specific method, but a similar option that results in greater data recovery per respondent.

1.1.1.3 *Double Binary Discrete Choice* (Recommended)
The double binary discrete choice method largely follows the same protocol as the binary discrete choice method. In addition to asking each respondent about their WTP for a single presented value, however, this method follows up with a second question. For example, respondents may be asked if they would be willing to pay double or half of the value that was presented to them in the first question. This allows for greater data recovery as a result of each individual survey, making each one more useful and cost effective.

One downside of this method is that the addition of a follow-up question complicates collected data, making them more difficult to evaluate. Despite this complication, we recommend this survey question style.

1.1.1.4 *Iterative Bidding*
The iterative bidding method presents respondents with a single WTP value, adjusts that value to a higher or lower value based on their response, and asks again. For example, an individual could be asked if they would be willing to pay $20. If they responded "yes," they would then be asked if they would be willing to pay $25, and so on. This method results in arrival at the most accurate estimate of individual WTP and is the "gold standard" method of contingent valuation.

The problem with this method is that it is difficult to administer in any form other than in-person interviews, which are expensive to implement. While in-person interviews are consistently considered the best way to elicit values and ensure survey quality, we do not recommend this method due to its expensive nature, and the training that would be required or surveyors to avoid bias.

1.1.2 *Choice Experiments*
Choice experiments, formerly referred to as attribute-based methods, involve a series of "multialternative experimentally designated choice questions" (Holmes, Adamowicz, and Carlsson, 2017), which help separate out individual impacts of a variety of values through repeated choices between alternatives. Choice experiments enable analysts to isolate individual ecosystem service values; typical contingent valuation methods assess total economic values but cannot clarify further. The ecosystem service values elucidated by Costanza et al. (1997) and de Groot et

al. (2002) and discussed in the ecosystem services section of our full report reflect a choice experiment method mixed with a few other approaches.

Choice experiment surveys require months of deliberations about formulation to properly isolate each question to a particular ecosystem services value. Typically, the surveys are longer and more mentally demanding for the responders. Respondents confused by the language or the questions can produce response bias, and—like all surveys—choice experiments suffer from self-reporting biases. Data analysis is also fairly complex. For an excellent, thorough, and easy-to-read discussion of choice experiments, see Chapter 5 of *A Primer on Nonmarket Valuation* (Holmes, Adamowicz, and Carlsson, 2017).

1.2 Revealed Preference Methods

Instead of explicitly asking an individual about their WTP for a good, sometimes it can instead be intuited from behavioral choices. In accordance with economic theory, it is assumed that humans are rational beings that seek to improve their own happiness on a day-to-day basis. It can then be inferred that when an individual makes a payment for a good or service, the benefit that they receive is greater than that payment. For example, an individual that pays $1 for an apple is assumed to receive over $1 in personal satisfaction and happiness, or else they would not have made the transaction in the first place.

Revealed preference models rely on this principle and assume that spending activities serve as a proxy for WTP. While true individual WTP likely exceeds this observable cost value, it serves as a low-end measurement. These measurements also do not carry the uncertainty associated with contingent valuation studies and other stated preference methods.

1.2.1 Hedonic Price Models

Hedonic price models – regression analysis or sales comparison/adjustment matrices – elucidate the degree to which each of many property characteristics contribute to the variation between real estate values in a sample frame. Extensive research over the last 35 years demonstrates that environmental amenities (such as proximity to a lake, or environmental quality) have significant influence on property values (Freeman, Herriges, and Kling, 2014). The proportional effect of access to environmental amenities can be developed into a regression, which can estimate the marginal WTP for the environmental amenity/characteristics.

To apply the hedonic price method, a data set requires information about internal and external property factors that influence price. For example, internal factors include structural characteristics of the building(s) on the property, acreage, and neighborhood characteristics. External factors include proximity to environmental amenities, the quality of the environmental amenities, market trends, and regional preferences. Data on these factors allow the analysis to isolate the impact of a particular effect – for our analysis, proximity to and quality of environmental amenities – net the effects of other factors.

A hedonic model would provide a fairly accurate understanding of the effect of the lake's presence and water quality on property values. Our water quality working group initially attempted to use a hedonic model to analyze the relationship between property values and water quality, but quickly discovered the intense data demand renders this method infeasible for the scope of this project. Typically, economists create hedonic price models after purchasing massive data sets from housing data vendors or working with a governmental body; the data gathering stage can take months, and the analysis even longer.

1.2.2 Travel Cost Analysis

Revealed preference methods can be applied to Lake Monroe in several ways to generate baseline WTP estimations. The following section addresses the different ways that we recommend obtaining these values, and how they have been incorporated into the drafted survey.

Park admission and travel costs represent two easily obtained values that all lake visitors must pay in some form. Even if respondents have a seasonal park pass, or are able to walk to Lake Monroe, they sacrifice time and money to travel and enter. Following the revealed preference methods logic outlined above, it is assumed that individual WTP is at least equal to these costs, although it is likely higher. The value of visiting the lake must exceed the direct and indirect costs of traveling and entering, assuming that the lake was the primary impetus for travel. One flaw with this analysis is that it does not account for the possibility that individuals might travel to the Lake Monroe area to receive benefits in addition to those received as a result of lake visitation.

2. Sampling Methods

2.1 Sample Frame

2.1.1 *Geographic Scope*

The sample frame is the population of interest that sampling aims to represent. Different sample frames have different applications. For geographic scope, the sample frame is targeted towards a particular region by using a buffer distance around a feature of interest or is based on a geographic unit of interest (*e.g.*, counties, state). The main sample frame options for this study are a population from a buffer around Lake Monroe, the populations of the counties of interest, or a statewide population.

The buffer area approach would draw a sample population zone around Lake Monroe based on either raw distance from the shore (region buffer), travel distance from the lake shore via roads (travel buffer), or distance from a point in the center of the lake (point buffer). While this approach could theoretically help increase research efficiency by reducing the population necessary to sample, it is difficult to determine where to set the cutoff for the buffer zone. Nearly any buffer zone will be by its nature arbitrarily selected. A buffer area approach systematically undervalues the ecosystem services of the Lake because it does not include travelers from outside the buffer zone who travel to Lake Monroe.

Setting the sample frame around only a few selected counties would allow the client to receive information on the counties of their interest while simultaneously minimizing sampling costs. Like the buffer area approach, the selected counties approach also undervalues the ecosystem services of the Lake by not including the value that populations outside those counties receive.

Setting a statewide sample frame allows the client to know about full state revenues and values of the Lake, which might be useful in state-level advocacy; however, a state-level sample frame drastically increases the necessary sample size for good statistical power and therefore increases implementation costs.

2.1.2 *Temporal Scope*

The temporal scope of a contingent valuation study is largely restricted by cost and timing concerns. Sampling over multiple periods throughout the year would account for more variability and produce less biased data; however, it would increase the time demands and expense of survey implementation. On the other hand, a one-time survey pulse would require less money, time, and analysis workhours, but would not capture seasonal variation and other confounding variables.

2.2 Sample Selection

Because serving a survey to all members of a population is not feasible, studies must select a subset – a sample – of the population to assess. Sample selection methods determine whether the sample is truly representative of the full population. Some sample selection methods cause unobservable bias in the measured outcomes, which decreases the validity of a study's results.

2.2.1 *Probability Sampling* (Recommended)

Probability sampling includes a variety of techniques. Simple random sampling and stratified random sampling are most relevant to the study at hand. Simple random sampling involves selecting individuals from the full population at random until the goal sample size is achieved. Correctly administered random sampling ensures that the sample is representative on average of the full population for all characteristics. If the sample is randomly selected and passes covariate balance checks, random sampling eliminates bias in measured results and can be generalized to the whole population.

Stratified random sampling separates the full population into subsets (strata) based on an important characteristic (or characteristics), then samples randomly from within each stratum until a goal sample size is achieved for each. Stratified random sampling eliminates bias in the same manner as simple random sampling and has the added benefit of generating representative values for each stratum.

The primary drawback of random sampling is the logistical burden. Serving a survey to the sample requires mailed surveys or increased interview travel/workhours compared to other methods, because the selected individuals cannot all be surveyed in one place. Stratified random sampling, though it increases the specificity of survey results to subsets of interest, requires larger sample sizes and therefore increases the monetary and logistical burden of the survey.

2.2.2 *Random Sampling Techniques*

Historically, public opinion researchers implemented telephone surveys via random selection of numbers from phone book records or random digit dialing (RDD). Because of the increasing ubiquity of cell phones and declining use of landlines, random selection from phone book records does not capture the full population in an area (AAPOR, 2016).

To sample via RDD, investigators apply the area code(s) of interest to phone numbers generated with a random number generator. However, because cell phone users can move and retain their original area code, RDD does not capture the full population of an area. RDD in some areas is also likely to generate a majority of phone numbers that are owned by businesses rather than residents (ICPSR, 2019).

Because area codes in rural areas are generally shared across several counties, an RDD sampling method for stratified random sampling between counties would not allow investigators to select samples before beginning the survey. The resulting error would lead to larger minimum sample sizes than with other methods. For example, Jackson, Brown, and Monroe counties share the (812) area code (AllAreaCodes, 2019). Because there is no way to pre-determine the county in which a randomly generated (812) phone number resides, surveyors would need to sample more respondents to be sure they achieved their desired minimum sample size for each county.

Because of the limitations of phone-based sampling, the primary technique for effective random sampling in public opinion research is address-based sampling (ABS) (Link et al., 2008). The

Computerized Delivery Sequence (CDS) address database maintained by the United States Postal Service (USPS) represents a majority of households in most parts of the United States, with 100% coverage in many areas (AAPOR, 2016). CDS data is through USPS-licensed vendors, like Valassis Lists, that might also append additional useful information (*e.g.*, demographics) to the addresses (Valassis, 2019). ABS with CDS data is the technique most likely to produce representative samples; because the data is spatial, it allows investigators to efficiently pre-select the minimum possible sample size, saving money and time over the RDD method.

Address information can also be gathered using geospatial information systems (GIS) datasets, software, and processing. This option provides an affordable means to gather the addresses, stratify the sample, and print mailing labels. However, if FoLM does not have in-house GIS expertise and resources, the organization will have to ensure that any individual tasked or hired with preparing the survey for implementation has at least intermediate experience using GIS and access to GIS software, such as ArcGIS. Although this approach has minimal costs outside of labor and software (if needed), FoLM should note that gathering the datasets is a lengthy process. With this consideration, two-three weeks for a qualified GIS user to gather datasets should be budgeted into the organization's timeline for implementing the CV.

The step-by-step method for using GIS to gather addresses is included in Appendix N. This data is published by 39 Degrees North, LLC (39ºN), which partners with the Association of Indiana Counties and the Indiana Association of County Commissioners to provide a platform for sharing the most-current county and state-level GIS data. In order to begin selecting residential addresses, FoLM should determine the property classes (Appendix N) they would like to target and query for the survey. Again, is this most time-consuming part of the GIS processing because 39ºN can download only 500 records in a single query. The data from 39ºN can be downloaded in CSV format and then uploaded to GIS software for processing. Here, the data should be "stitched" together into a single file and then constrained to FoLM's selected sample area. The final processing steps will include stratifying your sample and producing a CSV file, which will be used to generate mailing labels.

2.2.3 *Non-Probability Sampling* (Acharya et al., 2013)

Non-probability sampling selects individuals to sample through non-random methods, resulting in selection bias from unobserved confounding variables. Although the bias can be reduced through the extensive use of analytical techniques like fixed effects and covariate analysis, the bias cannot be completely removed. Any data collected with non-probability sampling methods cannot be used to infer causality; for example, CV survey results could not prove that lake proximity caused increased property values. Non-probability sampling methods also render the results non-generalizable, meaning the results cannot be said to apply to any group besides the precise group sampled.

Generally, non-probability sampling will over-sample populations with intense feelings on a subject and under-sample more neutral populations (Freeman, Herriges, and Kling, 2014), resulting in either a strong over- or under-estimation of the true population average value, the

direction generally reflecting the attitude of the researchers toward the issue. For example, Azevedo et al. (2001) found a significant difference between the average WTP values of targeted subpopulations (anglers, recreational boaters) and randomly sampled individuals. Non-probability sampling also will not collect equal proportions of individuals from strata of interest, making stratified sample analysis difficult. What non-probability sampling lacks in ability to draw causal inferences, it makes up for in logistical simplicity. Convenience sampling, quota sampling, and snowball sampling are easy to implement, low cost, and can collect large sample sizes quickly.

2.2.4 *Convenience Sampling Techniques*

Convenience sampling is the most common sampling technique for public opinion research; it involves selecting individuals that are in a particular public/common location at the time the researcher is there, or otherwise selecting samples based on convenience. For example, researchers could spend several days at Lake Monroe handing out copies of the CV survey to any visitors to the Lake, collecting the surveys back on the spot. The researcher could also send the survey to lists of individuals they already have communication access to; for example, a researcher could send out a survey through email listservs, community organizations, nonprofit organizations, city governments, state parks, or utilities.

Quota sampling involves convenience sampling until a quota for a particular stratum is met, then not sampling any further individuals from that stratum and continuing to sample until the quota for each stratum is met. Quota sampling allows the researcher to approximate stratified sampling but is biased because of the convenience sampling aspect.

Lastly, snowball sampling involves randomly or non-randomly sampling an initial group and using information from the initial group to sample further survey respondents. One method for doing this is sending a link to an electronic survey to an email listserv, professional organizations, community organizations, or activist organizations and allowing the survey to be forwarded to more potential respondents. Snowball sampling is how most surveys conducted through social media operate. Snowball sampling produces highly biased estimates, because it tends to over-sample groups with strong opinions in one direction, depending on which group was more active in survey recruitment.

2.3 Stratification

Samples can be stratified according to any number of population characteristics, including demographics (*e.g.*, income, age, political ideology, and race), geographic location (*e.g.*, county of residence or distance from a feature of interest), and treatment group (*i.e.*, the version of the survey received). The more characteristics a study uses to stratify their samples, the larger the overall sample size needs to be for the results to achieve significant for each stratum. In other words, the benefits of having more specific data comes at the cost of larger sample sizes and logistical costs.

The main stratification options for this CV are to stratify by county and to stratify by distance from Lake Monroe. Both options would provide useful information to Friends of Lake Monroe, but the two options would require different implementation.

Stratifying by county would provide valuable information to FoLM in being able to tailor education and advocacy materials about the economic benefits of Lake Monroe by county. With a sample frame of the three counties of interest (Jackson, Brown, and Monroe), stratifying by county uses only three strata, increasing sample size requirements only slightly.

Stratifying by distance from Lake Monroe affords valuable information about how attitudes differ between those within easy travel range of the lake and those outside that range. Stratifying by distance alone would not allow a breakdown of results by county, which limits the usefulness of results to FoLM for tailoring educational and advocacy materials to county residents.

Stratifying by distance necessitates setting distance ranges of interest, and there is little research to suggest the appropriate distance for those sorts of boundaries. Most likely, stratifying by distance would require setting more than three distance ranges, which would increase sample size requirements more than stratifying by county. If sample sizes between distance ranges were held equal, many disparate areas far from the lake would be lumped together because of smaller population size, resulting in WTP estimates with higher standard errors.

2.4 Sample Size

Several varieties of calculations allow a researcher to minimize sample size for a given level of statistical confidence (power) and margin of error. Confidence interval calculations can estimate the sample size necessary for each stratum or for the total sample to be statistically significant. Another method, Neyman allocation, efficiently allocates sample sizes among strata such that the total sample will be statistically significant and with as small a total sample size as possible. Monte Carlo simulations/analysis can provide a better estimate based on example data for the statistical analysis of choice (discussed in 6. *Data Analysis Methods*).

2.4.1 *Confidence Interval Calculation*

Confidence interval (below) based calculations can provide a basic estimate of sample size requirements.

$$\text{Confidence interval: } \bar{x} \pm z^* \frac{\sigma}{\sqrt{n}}$$

$$z^* * \frac{\sigma}{\sqrt{n}} \leq desired\ margin\ of\ error\ (ME)$$

$$n \geq \left(\frac{z^*}{ME} * \sigma\right)^2$$

Sample size is dependent on confidence level (typically 90%, 95%, or 99%), desired margin of error, and predicted standard deviation of the sample. Because mail and telephone surveys typically have response rates 10-70%, the sample size also must be adjusted according to predicted response rates. Standard deviation of the sample response is impossible to know before sampling,

but based on similar literature, it varies between $10-1800, with a mode around $30 (list literature in Appendix L)

For example, assuming a survey response rate of 30% and a sample WTP standard deviation of $120, a sample size of 461 for each stratum will provide an estimate of WTP with 95% confidence and a margin of error of only $20. For three strata based on county, the total sample size for all three counties in this example would be 1383. For more examples of conditions and how they affect stratum sample sizes, see the below table. For the full calculation sheet, see Appendix L (Excel).

Confidence Level	WTP Standard Deviation	WTP Margin of Error	Response Rate	Minimum N per Stratum	Total N (3 Counties)
90%	$90	$10	30%	731	2193
90%	$90	$20	30%	183	549
90%	$120	$10	30%	1299	3897
90%	$120	$20	30%	325	975
95%	$90	$20	10%	778	2334
95%	$120	$20	10%	1383	4149
95%	$90	$10	30%	1038	3114
95%	$120	$20	30%	461	1383

2.4.2 *Neyman Allocation*

If a researcher is only interested in the total sample estimate being statistically significance across several stratified samples, the researcher can use Neyman allocation (formula below) to efficiently distribute the minimum sample size across the strata proportional to stratum population size. Neyman allocation, a commonly used sample allocation method, is a subtype of optimal allocation.

$$n_i = n * \left(\frac{N_i * S_i}{\sum(N_i * S_i)}\right)$$

Where:
n_i = stratum sample size
n = total sample size
N_i = stratum population size
S_i = expected standard deviation for the stratum

For example, for three substrata (population sizes: Brown County = 15,000, Jackson County = 43,800, Monroe County = 147,00) with a $20 maximum margin of error, 95% confidence level, 10% expected response rate, and expected WTP standard deviations of $60-100, the minimum strata sample sizes should be the following:

- Brown County: 90-140
- Jackson County: 220-280
- Monroe County: 1360-2310

To calculate sample allocations using other parameter settings, use https://stattrek.com/survey-sampling/sample-size-calculator.aspx.

While Neyman allocation reduces the sample sizes relative to regular confidence interval calculations, it does not guarantee that the individual strata will have statistically significant results – only that the overall total average measurement will be statistically significant.

2.4.3 *Monte Carlo Simulations*

Monte Carlo simulations are the most technically appropriate method for sample size calculation to use with our chosen CV data analysis method (6.1 *Probit and Logit Regression*), but Monte Carlo simulations are more technically complex. To calculate the required sample size with Monte Carlo methods, the researcher must develop several randomly-generated mock data sets, run the chosen analysis on those data sets, and determine the power and significance of the results; the researcher then adjusts the sample sizes until they reliably receive an output with the desired significance and power from the smallest possible sample size.

Using Monte Carlo simulations to develop sample size estimates allows researchers to specialize the sample size calculations to the exact analysis method and account for possible outlier results; however, the method takes time and a deep understanding of the method and data analysis. Due to time, resource, and knowledge limitations, we recommend using the less appropriate sample size calculations from 2.4.1 *Confidence Interval Calculation*.

3. Willingness-to-Pay Range Setting

For discrete choice contingent valuation studies to correctly estimate the WTP of the sampled individuals, the range of WTP options presented to the survey respondents must already be close to their true WTP. While some cutting-edge research exists on setting the WTP range using Monte Carlo simulations, the only feasible method to achieve accurate WTP values for non-expert researchers is to set the range of WTP presented using formal field testing/pilot surveys (Carson et al., 2003).

Pilot surveys involve setting the range of WTP options based on similar research, testing out the survey on smaller sample populations, and adjusting the WTP option range both up and down to see how WTP changes or stays the same. Pilot studies are expensive, because they require several thousand individuals sampled to be useful, and time consuming, because they necessitate several rounds of editing and development. Because pilot studies are expensive and time consuming, low budget studies must set wide WTP ranges with large step-sizes between increments and accept that their WTP estimates will have low precision.

4. Implementation Methods

4.1 Mail-Based Survey (Recommended)

Mail-based surveys are a survey mode in which a random sample of addresses are selected to receive surveys. This survey protocol typically follows the Dillman Method (Campbell et al., 2018), which consists of a notification of the intent to survey, an initial survey, a follow-up notification, and a replacement survey. The Dillman Method is costly because of the number of mailers. The method requires printed surveys, envelopes, postage, and workhours to prepare all the mailed material. The Dillman method has the advantage of reducing bias associated with in-person or phone-based survey protocols, such as social desirability bias. Marta-Pedroso et al. (2007) reported a response rate ranging between 24% and 30% for mail-based surveys.

Mail-based surveys should follow a set of literature-supported best practices to maximize survey response rate. Tan envelopes elicit a higher response rate than traditional white mailing envelopes (Edwards et al., 2009; Lavarkas et al., 2018). Personalized addressee lines, such as "Parent/Guardian" versus "Resident," have not had a clear stand-alone effect on response rates (Lavarkas et al., 2016; Larvarkas et al., 2018). Some research has examined the use of hand-written labels and indication of university sponsorship (Lavarkas et al., 2018).

4.2 Web-Based Survey

To implement a web-based survey, researchers create an online survey and ask recipients to respond through whatever means they have available. Some researchers use advertisements to elicit increased participation in web-based surveys (Lindhjem and Navrud, 2011). Web-based surveys have been paired with other modes to elicit responses, such as a paired mailing and web-based approach.

Web-based surveys can either be used with random sampling or targeted/convenience sampling. Targeted/convenience sampling is a popular choice because researchers can direct the link to easily accessible email account lists, such as organizational list-serves. Web-based surveys are less costly than other survey modes in terms of work-hours and materials needed. Web-based surveys also have the advantage of being more time efficient than other survey modes (Olsen, 2009), such as the reduction in lag time between when a survey is sent out and its response received.

Web-based surveys present issues with sample coverage and representativeness. Web-based surveys require respondents to have access to and operational knowledge of computers and the internet (Olsen, 2009). Populations with low levels of internet access and knowledge (*e.g.*, low-income, elderly, and/or rural populations) are less likely to respond. This may produce non-response bias where there are systematic differences between the responses given survey participants and the unattained responses of non-participants (Lindhjem and Navrud, 2011). However, studies have suggested the output mean WTP estimates from web-based surveys do not significantly differ from mail-based surveys (Olsen, 2009; Lindhjem and Navrud, 2011; Winkle and Rolf, 2011). Marta-Pedroso et al. (2007) reported a range for web-based emailed surveys response rates from 5.1% to 62%, with the large variability potentially linked to the use of follow-up communications.

4.3 In-Person Survey

Generally, researchers regard in-person surveys as the preferred approach for CV studies (Olsen, 2009), due to the ability to communicate and clarify information if the respondent is confused. In-person surveys require researchers to have individuals go out to areas and approach potential respondents for participation in the survey. The in-person survey mode is very costly due to a large number of workhours required. Additionally, conducting the required amount of in-person surveys within a target population is time consuming. In-person surveys can be subject to social desirability bias, in which respondents may choose to report socially approved behaviors rather than their true preferences (Lindhjem and Navrud, 2011). In-person surveys may have the benefit of a higher response rate than other survey modes (Marta-Pedroso et al., 2007). Marta-Pedroso et al. (2007) reported a response rate for in-person interviews ranging from 78% to 97%.

4.4 Mixed Modal

Mixed modal surveys utilize two or more survey modes, such as pairing elements of mail-based and web-based survey protocols. Using mixed modal designs reduces costs and validates responses. Richard Carson, a leading contingent valuation researcher, recommends utilizing mix modal survey techniques (Carson, 2000). Carson recommends a combination of phone and mail-based surveys, where survey respondents are recruited using an initial phone sample, then mailed visual aids and background information for the survey with questions asked over the phone. This can reduce costs of travel and man hours associated with a purely in-person survey mode, and additional mail materials needed in a purely mail-based survey mode.

4.5 IRB Approval Process

Friends of Lake Monroe as a non-profit entity would not require review and approval from the Institutional Review Board (IRB), unless Indiana University (IU) personnel are involved in the implementation and analysis of the survey and survey data. If IU personnel are involved, a survey in which private information is acquired from individuals may require IRB approval. IRB approval may be required for gathering of data of individuals that is identifiable and private or non-observable data (“Using human subjects,” 2019). If the scope of the research is to conduct a systematic analysis that goes towards generalizable knowledge rather than programmatic improvement, it may be subject to IRB approval.

5. Bias Reduction Methods

5.1 Biases Specific to CV

In the over 50 years since the use of CV surveys began, researchers and critics of the method have identified a number of ways respondents strategically or inadvertently misrepresent their WTPs (Mitchell and Carson, 1989). They have found that close attention to survey design was necessary for minimizing the chances of distorted responses. In the first category of bias, respondents misrepresent their WTP based on how the scenario is presented in the survey. Individuals respond in a way that does not reflect their valuation of a public good, but rather their desired level of provision of the good or their desired level of payment for the good. The second type of bias describes how survey design can influence respondents' decisions. For example, the order of the questions, the range of possible responses, the description of the good being valued, and indirect indicators of valuation can change how the respondent perceives their own preferences. The final category of bias in CV responses largely originates from gaps between the respondents' and the researchers' perceptions of the market context or the good presented in the survey.

5.2 Pretesting and Focus Groups

The potential for bias in CV design or respondent answers can be greatly reduced with taking the time to pretest the survey instrument before gathering data. Given the time, labor, and resources necessary to produce a high-quality valuation from the CV method, pretesting can reveal costly flaws in survey design that are otherwise difficult to identify

Because it increases the potential to avoid costly mistakes and obtain meaningful survey responses, pretesting is considered both necessary and standard when carrying out a CV study. Appropriate methods for pretesting include using focus groups, observing or recording mock interviews, debriefing trial survey respondents, and launching mini-surveys (Mitchell and Carson, 1989). While carrying out a focus group, researchers can learn first-hand how individuals perceive of the good being presented and its context. Moreover, this process allows researchers to fine-tune their survey design and interviewing techniques before actually eliciting public input.

6. Data Analysis Methods

6.1 Probit and Logit Regression

To analyze WTP from binary survey responses, researchers use the maximum likelihood estimator (MLE) of a logarithmic probability (logistic or "logit") or probability unit ("probit") regression. Probit and logit functions regress the likelihood of a particular response in a binary choice on explanatory variables. In the context of contingent valuation through binary choice questions, researchers can process MLE coefficients for the model variables to calculate the average WTP or WTA for a sampled group. Because probit and logit regressions function in essentially the same fashion (they differ primarily in their standard error model), we treat the two function types as interchangeable in this section.

To explain logit functions, we first explain linear regression for binary variables. A linear regression model of a binary response variable uses an independent predictor variable (*e.g.*, cost value asked in a survey question) to determine the extent to which the variable explains the probability the binary response variable (*e.g.*, yes or no response to the question) will be a particular value (generally the positive response):

$$Prob(Response_i = 1) = \propto + \beta(asked\ amount_i) + \varepsilon_i$$

Because linear regressions fail to accurately represent binary variables for a variety of reasons (UCLA IDRE, 2018, p.6), researchers instead tend to use logistic models. Instead of using raw probability of a positive response as the dependent variable, logistic models use the logit: the logarithm of the odds of a particular binary response, where the odds are the probability (p) divided by the complement of the probability:

$$logit = \log(odds) \text{ where } odds = \frac{p}{1-p}$$

The logistic regression model can incorporate a number (k) of independent explanatory variables (x) for each observation (i), where particular coefficients (β_1, β_2) describe the extent to which an independent variable explains variation in the logit:

$$\log\left(\frac{p_i}{1-p_i}\right) = \propto + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots \beta_k x_{ki}$$

To interpret the logistic regression results, researchers use the MLE, a complicated calculation which most statistical packages will provide as standard output for a logistic or probit model. For example, the values boxed in blue and red in Figure 1 below are MLEs for the intercepts and primary explanatory variable.

Figure 1: Examples (see Appendix M) of MLE for probit and logistic models.

The Probit Procedure

Analysis of Maximum Likelihood Parameter Estimates							
Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	-0.0082	0.0721	-0.1495	0.1331	0.01	0.9095
Ask13	1	-0.0004	0.0005	-0.0013	0.0005	0.71	0.3995

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.0131	0.1151	0.0129	0.9097
Ask13	1	-0.00064	0.000756	0.7088	0.3999

To calculate the average WTP for a sample from MLEs, researchers use the following generalized equation:

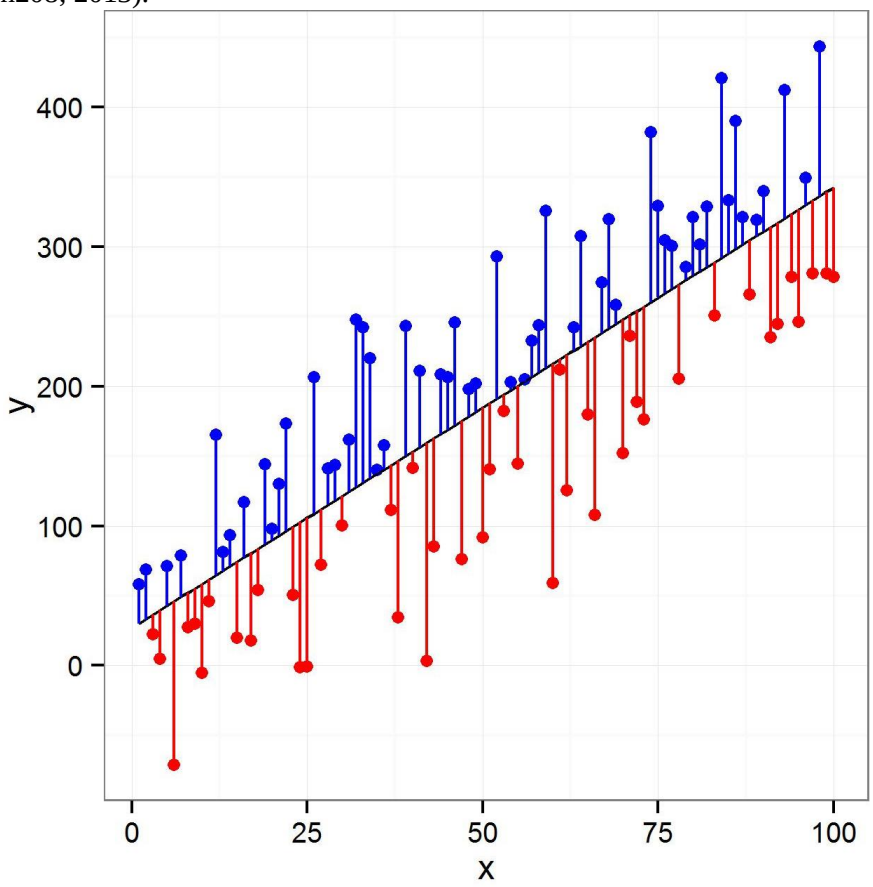
$$WTP = -\left(\frac{intercept\ estimate}{ask\ estimate}\right)$$

Logistic and probit models with covariates require a more complicated WTP calculation, described in detail in Appendix M. For a thorough theoretical treatment of the use of logistic and probit models for WTP estimation in economics, see Lopez-Feldman (2012). Modeling double binary discrete choice contingent valuation data with logistic/probit regression is too complicated for the Capstone team to pursue (Dr. David Good, personal communication, 23 April 2019); if FoLM wishes to use the additional data gathered through the double binary discrete choice conditional questions, we recommend hiring a professional data analyst.

6.2 OLS Regression

Ordinary least squares (OLS) regression finds the "best fit" line for the relationship between variables by minimizing the "residuals." Residuals are the distance from the calculated line for each actual observation. For a visual explanation, see Figure 2 below.

Figure 2: Visual demonstration of positive (blue) and negative (red) residuals from an OLS regression (black) between variables x (horizontal axis) and y (vertical axis). Figure from a LaTeX Stack Exchange thread (MYaseen208, 2013).



One method to analyze the output data from a double binary discrete choice contingent valuation question would be the following steps:

- For a survey question structured as "Would you be willing to pay Y amount for this service? If yes, would you be willing to pay double? If no, would you be willing to pay half?" enter the data from the survey as follows:
    - If answers are [no, no], enter the WTP response as 0.
    - If answers are [no, yes], enter the WTP response as Y/2.
    - If answers are [yes, no], enter the WTP response as Y.
    - If answers are [yes, yes], enter the WTP response as 2Y.
- Run an OLS regression in a statistical package of your choice, regressing the WTP response as the dependent variable (Y) upon all covariates (X) used in the survey. Include in the regression covariates and fixed effects from the demographics section of the survey.
- Option: Run three additional OLS regressions.
    - Use the responses to the first yes/no question only.
    - Use the responses for those that answered yes to the first question only.
    - Use the responses for those that answered no to the first question only.

We recommend including covariates for age, family size, and income level; we also recommend running several versions of the model with fixed effects for the passive use value variables from Question 17, sex, education level, and lakeside property ownership. See the list of covariates in Appendix M.

If survey respondents are randomly chosen from the population, randomly assigned to survey WTP values, and the data analyst confirms the sample groups are truly random through covariate balance checks, the regression may have a causal claim. However, the model will undoubtedly not control for unobserved time-invariant and time-variant characteristics that can influence the WTP outcome, making the model biased and unable to draw causal claims. The coefficients for each covariate should be interpreted as the degree to which a one-unit change in the covariate is correlated with a change in the dependent variable. In other words, the covariate coefficients in the model explain how that characteristic of a respondent affects their WTP or WTA.

Calculate a confidence interval for the survey responses to estimate average WTP and standard deviation in WTP for the sampled group.

6.3 Travel Cost Analysis

In travel cost analysis, WTP is calculated by estimating a demand curve which is a function of travel cost, time cost, and price. By multiplying total miles traveled by the cost of gas and the number of trips taken over the course of a given year, a tangible travel cost is obtained across all respondents. Added to this value is the admission price that those individuals were charged during the same year. If they purchased an annual pass, then that value is added as a flat cost, and if they paid for visits individually, then that reported cost is multiplied by the number of times that they visited the lake. Finally, travel time must be taken into consideration, because any time spent traveling could have been spent in its "next best use." In order to obtain this value, some sensitivity analysis must be performed, because it is impossible to precisely value an individual's time and how it is spent. One common way to value opportunity cost is by considering a percentage of an individual's wage. By using a range of percentages, this analysis can provide a range of acceptable travel cost estimates.

Total admissions were found using the following formula:

$$A = \sum_{1}^{N} (\$AP) + \sum_{1}^{N} (\$DP \times n)$$

Where:
A = total admissions paid over the course of the sample year
N = sampled households
$AP = the cost of an annual pass
$DP = the cost of a daily pass
n = number of visits made over the course of the sample year

The total cost of gas over all miles driven was found using the following formula:

$$G = P \times \sum_{1}^{N} (n \times m)$$

Where:
G = the total cost of gas
P = the price of gas
m = miles driven per household

In order to address for the constantly fluctuating price of gas, a low-end cost estimate of $2.00 was used to represent P in one iteration, as was a high-end estimate of $3.00 in a second. This range provides a realistic margin of possible gas prices and thus the total costs of gas borne by all park visitors.

We assumed for purposes of this analysis that the opportunity cost associated with travel time was a function of household wage. This assumption is commonly made in the economics literature for lack of a better proxy. In the recreation literature, 25% is generally understood as an appropriate lower bound for the percent of earned wages that can be accurately equated to opportunity cost, with a maximum upper bound of 100% (Amoako-Tuffour and Martínez-Espiñeira, 2011). To keep FoLM recommendations more conservative, lower and upper bounds of 25% and 75% were used respectively. It was assumed that the average individual is paid for work 40 hours each week for 52 weeks out of the year.

Total opportunity cost was found using the following formula:

$$OC = \sum_{1}^{N} (h \times \frac{I}{2880} \times n \times f)$$

Where:
OC = opportunity cost
I = annual household income
h = hours traveled
f = opportunity cost wage multiplier of .25 or .75

Total survey respondent travel costs were calculated by summing all of the above values:

$$Total\ Survey\ Respondent\ Travel\ Cost = A + G + OC$$

In order to extrapolate these costs to the entire county of interest, the total number of individuals in all sampled households was found, and then divided by the total county population to arrive at the percentage of individuals in the county successfully sampled and therefore accounted for

within this analysis. Total survey respondent travel cost was multiplied by 100 and then divided by this percentage to magnify survey results to the full county level. It can be assumed that the revealed costs are less than the current benefits provided to county residents by Lake Monroe.

7. Budget Information

These printing cost estimates are based on a five-page survey, which is the length of the one provided. Please note the printing costs are not final until firms have seen the final file. Postage costs are not included.

7.1 Mailing and Printing Costs

FoLM could work with Indiana University and use Document Services on campus. This requires cooperation with a faculty member and replies to be sent to an IUB office. The total cost for their services is $2,304.00, from the following component costs:

- $792.00 to print and fold 3,600 surveys
- $639.00 for return mailer envelopes
- $297.00 for mailer envelopes
- $468.00 to insert surveys into envelopes
- $108.00 to address envelopes

Moeller Printing is a service in Indianapolis that does printing and mailing in house. The total cost for their services is $2,149.52, from the following component costs:

- $724.43 for 3,600 postcards
- $246.74 for #9 envelopes
- $0.53 per survey for handling (print, stuff, mail) = $1908.00

White Rabbit is a printing service in Bloomington, Indiana that offers discounts to non-profit organizations. However, with this service, FoLM would need to handle stuffing, mailing, and addressing of the surveys. The total cost for printing through this firm is $1,400 ($0.40/unit).

No postage costs are included in any mailing estimate because postage is dependent on the final weight of the package. To be eligible for business reply mail envelopes, Friends of Lake Monroe will have to apply for an account with USPS (“Business Reply Mail,” 2019). The USPS account would allow FoLM to pay for postage for survey respondents. Otherwise, receivers will be responsible for postage on the survey reply, or FoLM could include a stamp with every survey (for a cost of $1,980.00).

Should FoLM decide to prepare and disseminate the surveys in-house, the United States Postal Service (USPS) offers programs that allow non-profits to target mail route recipients and save on postage costs (“Every Door Direct Mail,” 2019). The USPS Every Door Direct Mail (EDDM) program allows organizations to select spatial and demographic characteristics of their target populations. The webpage interface for EDDM includes options for FoLM to set an extent for their sample by specifying an address or zip code and then selecting a set radius (up to 15 miles) or drive time (up to 15 minutes). Moreover, this tool automatically includes multi-unit dwellings, such as apartments and townhouses, which further reduces the cost of acquiring information. Once the area of interest is set, customers can then select mailing routes and target demographics, including but not limited to household income, household size, age of residents, homeowner status,

and gender. Once characteristics of the target population are selected, the website provides information on how many households will be included in the mailing list, as well as an estimated cost for services. If FoLM maintains a sample size of 3,600 across Brown, Jackson, and Monroe counties, the total postage is approximately $700.00 at the rate of $0.187 per parcel.

In order to meet eligibility requirements for the EDDM program, senders must meet set size and weight requirements. Whether sending a large (letter-sized) or standard-sized parcel (business envelope), each piece must weigh less than 3.3 ounces. This is equal to about 15 pages, one envelope for sending, and a reply envelope. Furthermore, the USPS requires EDDM senders to bundle their materials in sets of 50-100 and charges lower rates for machine-readable parcels.

Although this option provides a low cost of accessing and sharing information, this method may cause the target population to be concentrated in specific neighborhoods and reduce the stratification of the sample population. In light of this concern, the value of using EDDM could be increased by targeting the mailing routes according to household demographics or overlaying current GIS data with census data and mailing routes to ensure sample is sufficiently dispersed and within a set sample area.

In addition to EDDM, the USPS offers other cost-effective options for mailing to a target population. Using PS Form 3615, non-profits can apply for a Business Reply Permit, which costs $160 and allows organizations to pay only for postage of response mail. This option also increases survey response rates by decreasing the burden on respondents. If FoLM has not already done so, they may submit PS form 3624, the “Application to Mail at Nonprofit USPS Marketing Mail Prices. With this fee-free program, science-based nonprofit organizations that apply their work in the community are among the eligible programs. However, the USPS requires at least 200 parcels for each mass mailing.

7.2 Data Gathering and Input Costs

Marketing Systems Group is a private firm that assists with data gathering. Marketing Systems Group can provide stratified random address-based sampling from the USPS address database, which is updated monthly. The total cost for their services is $687.00 (Raj, Marketing Systems Group, personal communication, 8 April 2019). This includes 3,600 addresses (1,200 per county) and set up costs. Matching names with addresses costs an additional $275.00. Call 215-653-7100 and ask to speak with Raj, the consultant who provided this quote.

After the printing and mailing of surveys, FoLM will need to handle inputting the data for analysis. We calculated the approximate time it would take a summer intern to stuff surveys and input data for this project. Assuming it takes 30 seconds/survey to stuff, 30 hours should be allotted. For data entry, we assumed at 10% to 30% response rate (360 responses to 1,080 responses). Assuming two minutes per entry, the intern will require 12 hours to 36 hours for data input. Depending on the data analysis capability of the intern, analyzing the contingent valuation data may take up to 12 hours. The total hours for the intern ranges from 54 to 78. Assuming $8.00/hour, this adds $432.00 to $624.00 to the budget.

The costs for using EDDM vary according to time and expertise necessary to target the population according to sampling methods and mailing routes ("Every Door Direct Mail," 2019). As such some of the data gathering costs involve FoLM's decision-making process and transaction costs while using the EDDM website. While the option to personally target addresses can greatly reduce costs, FoLM may also consider outsourcing to printing companies that partner with the USPS to ensure compatibility with USPS EDDM standards. The only local company that is ensured by the USPS to reliably provide such services is Moeller Printing, Indianapolis, IN ("Moeller Printing," 2019). Operating for 87 years, this business has had no complaints filed with the Better Business Bureau ("Moeller Printing Co., Inc." 2019).

7.3 Total Budget

We calculated a high and low estimate for the budget, along with our recommended plan. The high estimate includes: Moeller Printing (Surveys, Follow-Up Postcards, #9 Envelopes), Marketing Systems Group data gathering, paid intern at 78 hours (assuming a 30% response rate), and stamps in every survey for return postage. With these assumptions, the total cost is $6,165.95. The low estimate includes: Moeller Printing (Surveys, #9 Envelopes), GIS data gathering, receivers responsible for postage, and FoLM volunteers being responsible for data input. These assumptions put the budget at $2,245.52. The recommended budget includes: Moeller Printing (Surveys, Follow-Up Postcards, #9 Envelopes), Marketing Systems Group data gathering, receivers responsible for postage, FoLM responsible for data input. The recommended budget is $3,656.96.

7.4 Project Funding

There are several funding options through Indiana University. A student or IU faculty could help FoLM carry this project out and apply for funding citing this survey as their research project (Hutton Honors College, Sustainability Research Development Grants, and Center for Survey Research Grants).

Lake Monroe is an important resource for many people, businesses, and communities throughout the region. Because the survey results would be useful for other organizations, fundraising is an option for covering the costs of this study. Businesses such as Scenic View and Four Winds have a large stake in the health of Lake Monroe and could be a valuable resource.

There are several grants specifically for environmental non-profits. The Patagonia Environmental Grant Program: Corporate Grants Program funds grants from $2,500 – $15,000 with a deadline of April 30th or August 31st. The application will have to focus on how the research will be link to direct action (*e.g.*, formulation a watershed plan). The Clif Bar Family Foundation provides grants, but do not publish the award amount. The deadline is June 1st. Grant applications to the Clif Bar Family Foundation must focus on reducing environmental health hazards, building stronger communities, and creating a robust, healthy food system. FoLM could emphasize the focus on maintaining a healthy watershed which has agricultural areas. The Ben and Jerry's Foundation awards up to $25,000.00 to selected applicants who meet the October 16th deadline. The foundation is looking for grassroots, constituent-led group organizing for social change. The description is "organization is looking at root cause, community and ally outreach, mobilizing constituents and

allies," which FoLM could easily demonstrate. The grant maximum limit is $500,000. We have provided a resource that is regularly updated with grants specifically for environmental groups (Corporation for National and Community Service, 2019).

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Appendix L: Contingent Valuation Sample Size Calculation

Attached as an Excel file.

Appendix M: Contingent Valuation Survey Analysis SAS Code

CV Data Analysis: Steps

1. Prepare the data for analysis in SAS. Enter the survey data into each county's Excel file as written in Appendix F. Move the data from the Raw Data sheet of the file to the CVdata sheet of the file as follows:
    a. When copying data from the Raw Data sheet of the Excel file into the CVdata sheet, do not include headers/titles (*i.e.*, the first four rows in the Raw Data sheet).
    b. Copy data from column S ("Ask10") from Raw Data and paste it into column A ("Ask10") of the CVdata sheet.
    c. Copy data from column T ("choice 1") from Raw Data and paste it into column B ("Response10") of the CVdata sheet.
    d. Copy data from column W ("Ask13") from Raw Data and paste it into column C ("Ask13") of the CVdata sheet.
    e. Copy data from column X ("choice 2") from Raw Data and paste it into column D ("Response13") of the CVdata sheet.
    f. Copy data from column AB ("future") from Raw Data and paste it into column E ("future") of the CVdata sheet.
    g. Copy data from column AC ("children") from Raw Data and paste it into column F ("children") of the CVdata sheet.
    h. Copy data from column AD ("visit") from Raw Data and paste it into column G ("visit") of the CVdata sheet.
    i. Copy data from column AE ("family") from Raw Data and paste it into column H ("family") of the CVdata sheet.
    j. Copy data from column AF ("lake id") from Raw Data and paste it into column I ("lakeID") of the CVdata sheet.
    k. Copy data from column AG ("nature id") from Raw Data and paste it into column J ("natureID") of the CVdata sheet.
    l. Copy data from column AH ("none") from Raw Data and paste it into column K ("none") of the CVdata sheet.
    m. Copy data from column AI ("sex") from Raw Data and paste it into column L ("sex") of the CVdata sheet.
    n. Copy data from column AJ ("age") from Raw Data and paste it into column M ("age") of the CVdata sheet.
    o. Copy data from column AK ("count") from Raw Data and paste it into column N ("famsize") of the CVdata sheet.
    p. Copy data from column AM ("income") from Raw Data and paste it into column O ("inclvl") of the CVdata sheet.
    q. Copy data from column AN ("home") from Raw Data and paste it into column P ("property") of the CVdata sheet.
    r. Copy data from column AA ("influence") from Raw Data and paste it into column Q ("protest") of the CVdata sheet.
    s. In the CVdata sheet, delete rows with blanks in any column. Delete rows with a 4 or a 6 value in column Q ("protest"), because they are protest votes.

2. Get access to and open SAS.
3. Import data into SAS using the SAS Import Wizard, as this instructional video does: https://youtu.be/nYglL194MfI?t=8.
    a. File > Import Data to open the Wizard.
    b. Check "Standard data source" and select "Microsoft Excel Workbook from the dropdown menu. Click "Next".
    c. In the "Connect to MS Excel" window that pops up, click "Browse…"
    d. In the "Open" window that pops up, select "xlsx Files (.xlsx)" from the dropdown menu for "Files of type:". Find the county Excel file of interest on your computer. Select the file and click "Open."
    e. Click "OK" in the "Connect to MS Excel" window.
    f. In the "Import Wizard – Select table" window, select the "CVdata" option from the "What table do you want to import?" dropdown menu. Click "Options…"
    g. In the "SAS Import: Spreadsheet Options" window that pops up, make sure the checkboxes for "Use DATE format" and "Use TIME format" are *NOT* selected. Click "OK".
    h. In the "Import Wizard – Select table" window, click "Next".
    i. In the "Import Wizard – Select library and member" window, make sure that the dropdown menu for "Library:" has selected "WORK". In the dropdown menu for "Member:" type "CVdata". Click "Next". → This creates a SAS datafile named CVdata from the Excel file and puts it in the WORK library.
    j. In the "Import Wizard – Create SAS statements" window, click "Finish".
    k. When the Import Wizard window closes, the SAS Log should say
    NOTE: WORK.CVDATA data set was successfully created.
    NOTE: The data set WORK.CVDATA has [#] observations and 17 variables.
4. Verify that your data were correctly imported by viewing the data. You can do this by clicking on Libraries > Work > CVdata.

CV Data Analysis: Basic Model

5. In the Editor window, copy and paste the following code, if your SAS application allows it. If not, type the following code and double check for spelling errors and that every line of code ends with a semi-colon. This code will (1) adjust the response variable as necessary to analyze the data; (2) run a probit model for Question 10 without covariates; (3) run a logit model for Question 10 without covariates. We decided to run both a probit and logit model to provide robustness to your results: If the two models produce similar results, then we can assume the findings are sound.

```
data work.CVdatab;
set work.CVdata;
response10b=response10*-1;
response13b=response13*-1;
run;

proc probit data=work.CVdatab;
```

```
class response10b;
model response10b=ask10;
run;

proc logist data=work.CVdatab;
class response10b;
model response10b=ask10;
run;
```

6. Run the code you input during Step 5 by highlighting the code in the Editor window with your cursor and clicking Run > Submit. SAS will open a new window titled "Results Viewer – SAS Output". In this window, you should see a variety of tables listed under the heading "The Probit Procedure" and another set of tables under the heading "The LOGISTIC Procedure". The relevant tables for our analysis are the following:

The Probit Procedure

Analysis of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	-0.0451	0.0721	-0.1864	0.0962	0.39	0.5318
Ask10	1	0.0004	0.0005	-0.0005	0.0014	0.85	0.3559

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.0719	0.1150	0.3907	0.5320
Ask10	1	0.000697	0.000756	0.8514	0.3562

7. To calculate the average willingness-to-pay (WTP), use the following equation:

$$WTP = -\left(\frac{intercept\ estimate\ [blue]}{ask\ estimate\ [red]}\right)$$

For the probit example provided above, the WTP would be $112.75. For the logit example provided above, the WTP would be $103.16. Find the aggregate population WTP (*i.e.*, the value of the lake to the county) by multiplying the average WTP by the county population.

8. In the Editor window, copy and paste the following code. This code will (1) run a probit model for Question 13 without covariates; and (2) run a logit model for Question 13 without covariates.

```
proc probit data=work.CVdatab;
class response13b;
model response13b=ask13;
run;

proc logist data=work.CVdatab;
class response13b;
model response13b=ask13;
run;
```

9. Run the code you input during Step 8 following the procedure in Step 6. The relevant tables for our analysis are the following:

The Probit Procedure

Analysis of Maximum Likelihood Parameter Estimates							
Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	-0.0082	0.0721	-0.1495	0.1331	0.01	0.9095
Ask13	1	-0.0004	0.0005	-0.0013	0.0005	0.71	0.3995

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.0131	0.1151	0.0129	0.9097
Ask13	1	-0.00064	0.000756	0.7088	0.3999

10. To calculate the average willingness-to-accept (WTA), use the following equation.

$$WTA = -\left(\frac{intercept\ estimate\ [blue]}{ask\ estimate\ [red]}\right)$$

For the probit example provided above, the WTA would be -$20.50. For the logit example provided above, the WTA would be -$20.47. (Note: The test data used for this analysis was randomly generated, making negative values possible. Actual data will most likely not have this problem.) Find the aggregate population WTA (*i.e.*, the value of the lake to the county) by multiplying the average WTA by the county population.

CV Data Analysis: Covariates

Including covariates in the model will increase the accuracy of the WTP or WTA estimate by adjusting for demographic characteristics of the respondents. However, using covariates is far more complicated and will require a data analyst with experience with SAS and this variety of data analysis. The covariates of interest are coded in the following manner.

SAS Variable Name	Data Source	Variable	Possible Values
future	Question 17	Existence passive value	0, 1
children	Question 17	Inheritance/bequest passive value	0, 1
visit	Question 17	Option passive value	0, 1
family	Question 17	Family history passive value	0, 1
lakeID	Question 17	Lake identity passive value	0, 1
natureID	Question 17	Environmentalism passive value	0, 1
sex	Question 18	Respondent sex	0, 1
age	Question 19	Respondent age	16 to 100
famsize	Question 20	Family size	1 to 15
inclvl	Question 22	Family income	0 to 150000
property	Question 23	Ownership of lakeside property	0, 1

11. Begin by running the following code. The first section of code will run an experimental regression between the binary response variable, the explanatory variable (capturing the ask amount), and the potential covariates. Categorical variables are listed in the "class" line before appearing in the "model" line; continuous variables are only in the "model" line. The second section of code will calculate the mean and standard error of each variable in the regression.

```
proc probit data=work.CVdatab;
class response10b future children visit family lakeID natureID sex property;
model response10b=ask10 future children visit family lakeID natureID sex property age famsize inclvl;
run;

proc means data=work.CVdatab;
var age sex property future children visit family lakeID natureID inclvl;
run;
```

12. Look at the following table from "The Probit Procedure" and focus on those cells highlighted in red. Any variable with a Pr>ChiSq value less than 0.05 has a statistically significant impact on the WTP. In the table shown below, the variable FAMILY is the only one with a significant impact on WTP.

Type III Analysis of Effects			
Effect	DF	Wald Chi-Square	Pr > ChiSq
Ask10	1	0.0002	0.9883
age	1	1.6459	0.1995
sex	1	0.5323	0.4656
property	1	0.7218	0.3955
future	1	0.8651	0.3523
children	1	1.1865	0.2760
visit	1	0.8134	0.3671
family	1	5.0877	0.0241
lakeID	1	1.5760	0.2093
natureID	1	0.0166	0.8974
inclvl	1	0.1536	0.6952

13. Take the code from Step 11 and remove all variables except ASK10 and those marked as statistically significant in Step 12. Re-run the code. The output table will look slightly different, as below. For example, if the significant variables were AGE, SEX, PROPERTY, and INCLVL, the table might look like the following.

Analysis of Maximum Likelihood Parameter Estimates

Parameter		DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept		1	0.2099	0.1538	-0.0915	0.5114	1.86	0.1723
Ask10		1	0.0001	0.0005	-0.0008	0.0010	0.03	0.8603
age		1	-0.0026	0.0021	-0.0068	0.0016	1.47	0.2256
sex	0	1	0.0549	0.0761	-0.0943	0.2041	0.52	0.4710
sex	1	0	0.0000	.	.	.	.	.
property	0	1	-0.0596	0.0763	-0.2091	0.0898	0.61	0.4343
property	1	0	0.0000	.	.	.	.	.
inclvl		1	-0.0000	0.0000	-0.0000	0.0000	0.21	0.6488

The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
age	age	1090	49.4256881	17.8741771	18.0000000	80.0000000
sex	sex	1090	0.4935780	0.5001883	0	1.0000000
property	property	1090	0.4917431	0.5001613	0	1.0000000
inclvl	inclvl	1090	75694.36	42769.26	115.0000000	149996.00

14. Calculate the WTP with a modified form of the previous equation:

$$\propto = (intercept\ coefficient[green]) + (\overline{age}[black] \times \beta_{age}[red]) + (\overline{sex}[black] \times \beta_{sex}[red]) + (\overline{property}[black] \times \beta_{property}[red]) + (\overline{inclvl}[black] \times \beta_{inclvl}[red])$$

$$WTP = \frac{-\propto}{\beta_{ask10}[blue]}$$

15. Repeat Steps 11 through 14 for Question 13 responses (WTA), replacing RESPONSE10B with RESPONSE13B and ASK10 with ASK13.
16. For further discussion and examples of WTP and WTA calculations following this method, see the following resource: Lopez-Feldman, A. (2012). Introduction to contingent valuation using Stata. *Munich Personal RePEc Archive*, Paper No. 41018. Retrieved from http://mpra.ub.uni-muenchen.de/41018/.

Appendix N: GIS-based Address Data and Instructions

This appendix includes the step-by-step instructions for gathering and processing address data using ArcGIS software, MS Excel, and MS Word to create a population sample for the CV survey.

1. Download address data from Indiana Geographic Information Office and upload it to ArcGIS.
2. Extract County-Level Address Information
    i. Select "Select by Attribute" tool
    ii. Brown County Layer: "COUNTY_ID = 7"
    iii. Jackson County Layer: "COUNTY_ID = 36"
    iv. Monroe County Layer: "COUNTY_ID = 53"
    v. Select "Create Layer from Selection" for each county layer
    vi. Upload to default geodatabase
3. Extract Residential Address Information
    i. Select "Select by Attribute" tool for Brown, Jackson, and Monroe county layers, respectively
        1. Select "Get Unique Values" to generate values under PROP_CCODE attribute
        2. A list of values for property codes designated under the Indiana Property Tax Code will be generated. Values between 510-543 represent non-vacant residential properties.
        3. "PROP_CCODE" = insert all values generated under "Get Unique Values" that fall between 510 and 543.
        4. E.g., Select from [CountyName]_Addresses where "PROP_CCODE = '512' OR PROP_CCODE = '530' OR PROP_CCODE = '531'
        5. Select "Create Layer from Selection" for each county layer
        6. Upload to default geodatabase
4. Sampling residential address information
    i. Download "Sampling Design Tool" from arcgis.com (https://www.arcgis.com/home/item.html?id=ecbe1fc44f35465f9dea42ef9b63e785).
    ii. Go to the ArcMap main menu and select "Customize" and then "Add-In Manager"
    iii. Select "Customize" from the "Add-In Manager" dialogue window
    iv. Select "Add from file," locate downloaded "Sampling Design Tool," and select to upload to ArcMap. Close "Add-In Manager" box
    v. Select "Customize" from ArcMap main menu and go to "Commands" tab.
    vi. Select "Biogeography Branch" and drag "Sampling Tool" to your ArcMap toolbar.
    vii. Open Sampling Tool
    viii. Select "Select Samples from Frame" under "Sampling Type" and "Stratified Random" under sampling design. Be sure to also check the box labeled "Export Selected Features.

ix. Next, select your sample frame from the sampling tool's dropdown menu, which will be the residential address layer for each county
x. For "Strata Field" select PROP_CCODE and then "RUN"
xi. A window will pop up called "Select Stratified Inputs." Select "Proportional" under allocation method and then enter "2100" under "Sample units to allocate"
xii. Select "Run"
xiii. This will generate a stratified random sample weighted by property type of non-vacant residential properties in Brown, Jackson, and Monroe counties.

5. Excel file
i. Open Attribute Table for each county file and select "Export"
ii. Save in destination folder as a .csv file
iii. Select one address dataset which will be saved as your final address file and open in Excel.
iv. Under the Excel main menu, select "Data" and then "Get Data," "From File," and "From Text/CSV"
v. Select the .csv files created in step 'g' to add data for the addresses of the other two counties
vi. Add field "Label_Name" and populate all records in this column with "Current Resident." Refine data as necessary and save.

6. Word file
i. Open New Document.
ii. Go to "Mailings" under the main menu and select Label Vendor and Product Information (Avery Label 5160 was used in the MS Word file provided)
iii. Next from the "Mailings" menu, click "Select Recipients --> Use an Existing List." Select your saved .csv file from step 'h.'
iv. Select "Address Block" from the "Mailings" menu and then select "Match Fields" to extract address information from your .csv file. Select the "current resident" field, and then street, city, and zip code information.
v. Select "Merge to Adobe PDF" and save.

Appendix O: GIS Address Data

Address data gathered using the steps described in Appendix N will be provided digitally in a Word document.

Appendix P: Army Corps of Engineers Water Quality Data

Attached as an Excel file. Would be useful for a future hedonic price model of water quality.